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"THE BALTIMORE PLAN" OF CURRENCY REFORM.

By C. C. Homer and A. P. Hepburn.

IT requires no prophet to foresee that the question which must dominate all others in public interest during the coming twelve months, is that of reforming the polyglot system of currency and banking under which the commerce and industry of the United States are now struggling. Happily the tariff agitation has received its quietus for several years to come. If the Democratic tidal wave of 1892 was a protest against "Protection gone mad," it is idle to contend that the stupendous Republican victory of 1894 was not a protest against any further tariff tinkering by the party of radical revenue reform. Happily, too, the late elections have put an effectual quietus upon the pretensions of Populism. The blatant ignorance and absurd incompetency of the men it tossed into power have given ocular demonstration of the folly and fallacy of every theory that the party stood for. So, too, the earnest and aggressive advocates of free silver coinage have finally caused a popular upheaval which no one can misunderstand. The overwhelming defeat of the leader of the movement, Mr. Bland, a Democrat in one of the strongest Democratic districts of Missouri; the phenomenal victory of the sound-money Democrats in Republican California; and a popular majority of unparalleled proportions against the free-silver Democrats in Ohio,—these are definite expressions of aroused public opinion which show clearly that free silver coinage is a hopeless issue in the United States.

But back of the Populist demand for "more money" and "cheap money"; back of the sentiment favorable to silver coinage upon some safe basis; and back of the unrest and discontent which are

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manifest in all parties, there is the definite knowledge that our present currency system is both complicated and defective—that at certain seasons it is inadequate to commercial requirements, and in times of panic positively dangerous to the welfare of our people. This is the vital defect which gives plausibility to all the financial vagaries now prevalent; and whatever sins may be charged against the silver inflationists and the fiat money cranks, they must be credited with having finally aroused the conservatism of the country to a clear appreciation of the fact that financial reform is an imperative need.

It may be said that the movement for reform was inaugurated with the panic of 1893. The wholesale issue of clearing-house certificates, the widespread use of certified checks in place of money, and the premium, not on gold alone, but on currency as well,—these were object lessons in finance which brought home to every man the obvious truth that our currency system was defective, and that it lacked the essential quality of being readily expanded or contracted to meet perfectly legitimate requirements. Since that time the discussion has proceeded continuously in the daily press, and notably at all gatherings of commercial and banking organizations; and now comes the authoritative announcement from President Cleveland that the Secretary of the Treasury, Mr. Carlisle, will present at the coming session of Congress a plan of currency reform which will carry with it the recommendation and cordial support of the entire administration. This means simply that the currency question will henceforth take precedence over all others in public importance.

The pressing need for such action by our Treasury officials, and the heterogeneous character of our present currency system, can be best indicated by an exhibit of its component parts, as reported Oct. 1, 1894:

	Coined or Issued.	In treasury.	In circulation.
Gold coin	$579,728,587	$79,602,339	$500,126,248
Gold certificates	64,845,699	55,260	64,790,439
Silver dollars	421,176,408	366,900,165	54,276,243
Subsidiary silver	75,054,481	16,809,713	58,244,768
Silver certificates	339,676,504	9,155,785	330,520,719
Treasury notes (1890)	151,609,267	30,113,893	121,495,374
United States notes (greenbacks)	346,681,016	79,397,535	267,283,481
Currency certificates	56,305,000	550,000	55,755,000
National bank notes	207,564,458	5,017,748	202,546,710
Total	$2,242,641,420	$587,602,438	$1,655,038,982

In the language of Prof. J. Laurence Loughlin of Chicago, "We have here a dime museum of finance—'the greatest aggregation of curiosities ever before exhibited under one canvas in the world.' There are nine different and confusing kinds of money—two kinds of gold money, four kinds of silver money, and three kinds of paper money. The sum total of the four kinds of silver money amounts to

about the same as the sum of the two kinds of gold money. Briefly, about 35 per cent. is gold, 35 per cent. is silver, and 30 per cent. is paper. . . . If anything should make us pause and deliberate on the ways of regulating our monetary system, it would be that the loud-voiced, blatant demagogue is allowed to have unimpeded influence in regulating such an intricate mechanism as this. Is it not about time that unpartisan commissions should be consulted?"

We have, of course, no information as to the terms of the plan which Mr. Carlisle will propose; but recent events of the highest significance in this regard afford us a very clear indication as to what the situation demands and what the intelligence of the country will approve.—THE EDITOR.

At the last annual convention of the American Association of Bankers on October 11, 1894, the Clearing-house Association of Baltimore, as a body representing the banking interests of that city, presented to the convention an outline of proposed amendments to the national banking act, which has come to be known as the "Baltimore plan," and has called forth the strongest approval from influential persons in all sections of the country. In brief outline, the plan proposes that bond security for national bank notes shall be abolished; that the banks shall be permitted to issue circulating notes up to 50 per cent. of their paid-up capital (and under emergency provisions an additional 25 per cent. may be issued); that the notes of failed banks are to be paid out of a "Guarantee Fund" created by an annual tax on all national bank notes sufficient to cover such failures; that the government shall have a prior lien upon the assets of each failed bank and upon the liability of shareholders, for the purpose of restoring the amount withdrawn from the "Guarantee Fund" for the redemption of its circulation; and otherwise that the redemption of all national bank notes and the close scrutiny and supervision of all national banking affairs shall be carried on by the government as at present.

Mr. Charles C. Homer presented the plan on behalf of the bankers of Baltimore, and in the course of his address he said in part:

The solution of the currency problem is justly entitled to the greatest prominence, for modern history demonstrates that upon the character and stability of its finances depend the solidity and prosperity of a people. Commerce is the bond of union which ties together the nations of the earth, and welds the links that keeps destructive war chained captive to the chariot of peace. Money is the handmaid of commerce, and wheresoever the latter wanders in her search for healthful development, there her servant must be present, ready and able to respond to her commands. How important then the rôle of the dollar! It must be above suspicion; its character must be unquestioned; its value unchanging; its credit impregnable. How far much of our currency has been lacking in these necessary qualifications the finger of history has noted in indelible marks upon the pages of 1893.

From the birth of the first greenback, the patriotic student of finance has watched with solicitous eye the questionable assumption of constitutional power by our government; and while love of country and mindfulness of its dire needs softened the tones of warning involuntarily uttered, the cry of anguish could not be restrained when constant violations of our supreme law hurried us on to the calamities of 1893. Too much praise cannot be bestowed upon the far-seeing wisdom, the incisive judgment of our forefathers who framed the constitution of our country. "To coin money, regulate the value thereof, and of foreign coins," is the extent of the authority granted by this inspired instrument. Had its behests been regarded, the ruin, distress, and mental anguish we have just passed through would not have befallen our land.

We claim no novelty or originality for the plan which our Clearing-house Association has delegated me to present to you, and which it hopes may meet with the approval and advocacy of yourselves and of our entire country. Having lived and prospered for thirty years under the influence and blessing of the national banking system, which supplies every requirement except that of elasticity, we have aimed to outline an amendment which would not dwarf its good features, but which would be so broad and so liberal as to invite all state banks to come within its folds.

Our currency must be supplied by the banks,—*not by the government.* The banks are the arteries of commerce, feeling instantly the changes of commercial activity. It requires no demonstration or argument to prove that a flexible currency, responsive to the demands of commerce, can never be obtained so long as the institution issuing the same is required in advance to invest as much money or more in securities. To be elastic, it *must be based upon credit;* and the institution issuing the same must have for its sponsor the necessary government regulation, supervision, and examinations. The first Bank of the United States, which was allowed to issue circulating notes equal to the full amount of its capital, had in 1809 upon $10,000,000 capital $4,500,000 circulation, or 45 per cent.; in 1811, upon the same capital, $5,037,000, or 50 1-3 per cent. The second Bank of the United States, in 1835, with a capital of $35,000,000 had outstanding circulation amounting to $17,339,000, or 49½ per cent.

In the writings of Albert Gallatin, vol. iii, page 312, we find, speaking for the year 1830, the following interesting fact: "Among more than 300 banks, . . . the statements we have given show, that the average amount of notes issued by the state banks does not, taken together, exceed 44 per cent. of their capital." It is instructive to note that in 1859 Massachusetts had $61,819,000 bank capital with $20,839,000 circulation, or 29 3-5 per cent. and Louisiana $24,215,000 capital with $9,094,000 circulation, or 26 3-10 per cent. The laws of Massachusetts permitted circulation to double the amount of the capital, while no limit whatever was placed upon circulation in Louisiana.

To provide, however, for very extraordinary currency demands, such as confronted us all in 1893, we propose to permit the use of an additional 25 per cent., to be known as emergency circulation, subject to a severe tax. Its mission would be similar, but of broader utility, to that of clearing-house loan certificates, which performed such effective service last year, and by whose use immeasurable losses and ruin were averted.

The guarantee fund principle is not a new one. New York adopted it in 1829, but by an error or accident in framing the law, it was made to cover the deposits, as well as the circulation. Each bank was required to pay to the state treasurer one-half of one per cent. per annum upon its capital stock, until 3 per cent. had accumulated. In 1848, Millard Fillmore, then comptroller of the state, showed by his report, that the contributions to this fund had been $1,876,063, and the notes of failed banks amounted to only $1,548,558, leaving a surplus as against loss by circulation of $327,505.

Our currency must be national, its credit equally good North, South, East and West.

Commerce knows no state lines, and her hand-maid, the dollar, dare not halt upon the boundary of any state, timid as to her rights, hesitating as to her reception. In closing I can find no better words, in urging upon you the retention and adoption of the national bank system with the proposed amendments, than the following language of Mr. Horace White, whom we all esteem so highly:

"The public have more confidence in the machinery of governmental oversight and enforcement of law, under the national system, than they have under state systems; and this they will continue to have, though some state systems are as good or better. They know that the national system is uniform. It operates in the same way in Washington city and Washington state, and everywhere between. When you know this law, and the decisions under it, you know all that is necessary. If you undertake to learn and keep track of the banking laws of forty-four states and four territories, you will find your task a heavy one. There is now a movement on foot to secure uniformity of law in the states touching the marriage relations, wills, conveyances of land, and some other things. As we actually have uniformity of law on the subject of banking, we had best keep it."

Among the speakers who followed Mr. Homer in advocacy of the plan, was Hon. A. P. Hepburn, ex-comptroller of the currency under President Harrison. The following extracts from his address give in concise form a most admirable exposition of the requirements of the present situation and the merits of the system proposed:

Sound-money advocates, relying upon the impregnability of their position, until roused from their lethargy by the dangers that culminated in the panic of 1893, were for a period of years quiescent. On the other hand, the champions of silver, with mines to work and a commodity to market, and the representatives of debtor communities, have sounded and resounded the demands of increasing trade and growing population for more money. They struck a responsive chord in the honest conviction of many. They say, "Opposed to free coinage? What are you going to do? Population and business are increasing; our currency should increase in the same ratio. The government should not issue more fiat money. State-bank circulation is fraught with danger. National banks cannot supply currency, because government bonds as security are fast being retired. We must resort to silver as the only alternative."

The action of the bankers of Baltimore, so ably presented to the convention, and for which they deserve the thanks of the nation, is a complete answer to all this, and, Mr. Chairman, it is a timely answer. With the Republicans of California and the Democrats of Ohio demanding free coinage of silver at the ratio of sixteen to one, and varying shades of the same sentiment finding public and party expression in different localities, it is imperative that this convention of bankers formulate the principles upon which they believe the currency of the country should be founded.

Of all the time-worn fallacies there is none more venerable or vulnerable than the omnipresent attempt to create wealth or pay debts by legislation. The free coinage of silver at the ratio of sixteen silver dollars to one gold dollar of present weight and fineness, means a dollar commercially worth less than fifty cents, but by the fiat of the government made to pass for one hundred cents. It means that an individual may take $100 worth of silver bullion to the mint, and, coinage free, obtain silver dollars with which to pay $200 worth of debt, and would thus mean the repudiation of 50 per cent. of existing indebtedness. The sagacious instinct of trade would correct such wrong as to future contracts, by doubling the price of commodities. It means an inflation of prices without an increase of values. It means that the $600,000,000 of gold now in circulation would go to a premium, would cease to be money, would become a

commodity simply, whether coined or uncoined. *It means a contraction of our currency equal to the amount of gold which ceased to circulate as money.* It means a general unsettling of values, the demoralization of business, a great injustice to present creditors.

Both the Bland law and the Sherman law injected into circulation a fixed amount of money monthly, without regard to wants of commerce. However great the demands of trade, they could not increase such amount one jot or tittle. A currency to be elastic must be issued against credit. Banks must have power thus to create money. In no other way can currency be elastic. In no other way can it meet the wants of commerce. From the very nature of things the government cannot give such a currency. The banks can, and the banks only can with prudence and safety be allowed to do so. There is no more money in the country in 1894 than there was in 1893. Now money clogs the vaults of our banks and begs investment at a lower rate per annum than the premium offered one year ago for a single service, and which failed to lure it from hiding in safes and vaults. Any volume of currency may prove inadequate in a panic. Still, had the Canadian law obtained in this country in 1893, the national banks could, under its provisions, have added over $500,000,000 to the currency of the country, and with such a law a currency famine would hardly have been possible.

An elastic currency is needed, not alone in times of distrust, but in course of ordinary business. The harvesting of the cotton crop calls for an extraordinary amount of money in the cotton belt. Currency is brought from the money centers to supply this need. Currency in that section is expanding. Under the system proposed the banks in the cotton region could largely supply this local demand, and to such extent save the expense of expressing money from money centers. The cotton crop having been moved, the demand for money lessens, and by the inexorable law of supply and demand, the currency contracts, flows back to money centers.

The proposed law follows closely the Canadian law, which embodies many good features from the national bank act and from the British and Scottish currency laws. It provides for the issuing of currency up to the par of unimpaired capital. The Baltimore plan allows only 50 per cent., and in an emergency, 75 per cent. The Canadian currency is redeemed out of a 5 per cent. guarantee fund, contributed and maintained by the banks. The government assumes no responsibility beyond the application of this guarantee fund. There has been no loss to bill holders, and the law has given satisfaction. Canada has been peculiarly free from panics for many years, and has had no currency famine. Thus the principles of the bills before us are approved by actual experience.

Under our present law the government is bound to redeem all notes of all failed banks, and is given a prior lien upon the assets of the failed banks to reimburse such payment. With this proposed law in force and without bonds to secure circulation, the government would, during the past thirty-one years, have lost not exceeding $1,139,253. An annual tax of three hundreths of 1 per cent. upon circulation would have covered this loss. Surely a 5 per cent. guarantee fund will make the notes proposed in this plan perfectly secure.

The experience of thirty-one years of our nation's history, years replete with many periods of depression, yet withal characterized by marvelous growth in population and unprecedented commercial and financial development—certainly constitutes a safe criterion upon which to base legislation for the future. The experience of other nations as well as our own demonstrates the safety, the wisdom, the necessity of a currency based upon the principles embodied in the proposed plan.

The business of banking consists in swapping a well-known credit for a less-known credit. If the well-known credit be a check or draft, it is used for special purpose and

within business circles. If the well-known credit be in the form and semblance of money, a United States citizen is entitled to have it good as money throughout the United States.

History and experience point the wisdom of a national currency under national control; neither reason nor experience nor convenience nor public good would justify the creation of local currency. Under the proposed law, allowing circulation equal to 50 per cent. of capital, the banks could, and undoubtedly would, take out $350,000,000 of circulation, an increase of $150,000,000 over the present amount. The incorporated state banks have $250,000,000 capital, and should they, by conversion to the national system or otherwise, take our circulation, it would add $125,000,000 more—certainly sufficient for immediate wants, and being elastic, there is no danger of plethora, as it would flow back to the bank of issue whenever redundant.

Should Congress provide at any time for the retirement of the greenbacks or treasury notes, contraction may be prevented by increasing the percentage of bank-note circulation. All experience and all statistics prove a currency issue equal to par of unimpaired capital is absolutely safe.

By means of extensive correspondence with every considerable place in the country, I obtained statistics which justify the estimate that during the currency famine of 1893 there was issued clearing-house certificates to be used in settling balances, certified checks, certificates of deposit, and cashiers' checks in round amounts intended to pass as money, due bills from manufacturers and other employers of labor, and also clearing-house certificates in round amounts (in instances as small as 25 cents), all designed to perform the function of money, to the amount of $100,000,000. *They were issued against credit, and circulated as money upon the credit of the party issuing the same.* In other words, the want of elasticity in our currency system was thus partially supplied. *The government was powerless to afford relief. Its currency was as unresponsive to the wants of trade as the pyramid of Cheops.* Some banks borrowed United States bonds from savings banks and other institutions and took out circulation, but no bank could buy bonds and take out circulation without aggravating instead of reliving the money stringency.

We want legislation that will enable the banks to do, under proper restrictions and wholesome safeguards, what private firms and manufacturing corporations did do without restriction, except the possible liability to the 10 per cent. tax. The issuing of currency is a banking prerogative, and the interests of the public demand legislation that will enable the banks to afford such relief when necessary.

After such a presentation as is here indicated, it is scarcely necessary to say that the American Association of Bankers—the most imposing commercial body in the nation—gave the plan its formal endorsement. Since that time the banking and financial interests of every section of the country have given unmistakable evidence of approval; and judging by the outspoken commendation which it has received at the hands of our most influential economists, there can be no doubt that substantially the plan here outlined will at an early date be enacted into law. This too without regard to partisanship, for the business interests of the country will demand that Republicans and Democrats unite to enact a measure of such evident public utility.

SOCIAL IMPROVEMENT OF EUROPEAN LABOR.

By E. R. L. Gould, Ph. D.

VISITORS to continental Europe cannot fail to observe the large practical interest often manifested by employers in the social welfare of their help. Institutions have been founded and aids established which surpass anything in existence in Great Britain or the United States. My remark is to be interpreted generally. In two things, the provision of healthful homes for operatives and the foundation of workingmen's clubs, Anglo-Saxon countries make a more favorable showing.

Superficial observers have attributed this continental policy to an all-pervading spirit of paternalism or to an effort to hold the workingman in subjection, but they are in error. Wherever the institutions are most largely in operation, there is a keen appreciation of advantage on both sides, which makes both parties content to contribute. The initiative as well as the major expenditure belongs to the employer.

First of all it is important to apprehend clearly the principle underlying this general phase of social work. Broadly speaking, three leading ideas have been typified: the military, the patriarchal, and the spirit of philanthropic regard. The first two are often assumed to be most inclusive, whereas the third class is really the type.

Militarism in this field makes the worker a subject. His freedom is so entrammeled that individual or associated opposition to unjust treatment cannot well occur. Benefits doled at the good pleasure of the industrial captain either injure the recipient's self-respect and degrade his manhood, or arouse chafings and resentments.

Authority likewise supplants the idea of mutual help in a patriarchal régime. Under this system employés are minors with the day of emancipation indefinitely adjourned. Reciprocal regard plays no part in schemes organized on this basis. Enforced industrial serfdom is the real object.

The establishment of liberal agencies of social welfare must be placed on an entirely different plane. It so happens that philanthropy may be applied to industry on a satisfactory economic basis. Money may not be made directly out of every enterprise but there is none the less a distinct and positive return. The *sine qua non* of voluntary patronage, if I may so call it, is that the essential freedom of employés be respected. Wherever there is mutual contribution the principle of joint management must be effectively recognized. This is the sort of patronage which is really potent and it is the kind which

now prevails most largely in continental Europe, particularly in France and Belgium. Professor E. Cheysson, of Paris, recently published an interesting table of expenditures in a single year by ten of the largest coal-mining companies of France for the welfare of their help. The sums do not vary materially from year to year and are considered fixed charges. The following statement presents the facts:

NAME OF COMPANY.	Expenditures.		Per cent. of expenditures of total wages paid.
	Total.	Per workman.	
Roche-la-Molière et Firminy	$ 44,829.20	$16.60	7
Montrambert	41,600.00	19.00	8
Courrières	73,678.80	20.80	9
Bessèges	69,147.20	29.80	11
Auzin	313,551.40	27.20	12
Douchy	42,270.40	31.00	13
Liévin	68,344.00	31.00	15
Lens	164,200.00	31.00	15
Béthune	100,000.00	32.60	16
Blanzy	223,759.00	43.20	20

In one instance the sums thus spent amounted to 70 per cent., and for half the companies they amounted to more than 40 per cent. of the dividends paid to shareholders. Analyzing the outgo of the Blanzy corporation which is relatively the largest, we find that the subsidies accorded to the workmen's mutual aid society was $28,944.93; to the pension fund, $22,122.01; for medical attendance, medicines and hospital, $8059.03; to kindergartens, primary and apprenticeship schools, $34,923.43; advances of money made without interest, $2081.20; to bureau of public relief, $7690.72; for workmen's dwellings—interest, taxes, insurance and repairs (the gross rentals are fixed at 1⅓ per cent. of cost price), $37,071.89; annual loss of interest on money invested in mill and bakery, to furnish bread at cost price, $1747.86; value of coal furnished to workmen for domestic use, $63,955.30; to eleven musical and recreative societies, $3473.73; to sundry objects, including church, library, lectures and baths, $13,688.88.

French mining corporations do not stand alone in this phase of philanthropy. The railway companies contribute sums varying from 15 to 20 per cent. of their wage disbursements each year. The glass-factory at Baccarat accords subsidies equal in value to more than 2 per cent. of the capital stock and the ancient establishment at St. Gobain $16.40 annually for each employé. The great iron and steel works at Creusot sets aside annually $326,400 for the benefit of its 12,338 employés, and the far-famed chocolate establishment of M. Menier at Noisiel, over $10,000 for its 1500 workmen, besides paying 6 per cent. interest on deposits in the savings-bank, the deposits averaging

over $400,000 at the end of each year. The chemical works of Solwoy & Co., at Dombasle, support a peculiarly imposing array of institutions of welfare, as do the cotton-printing establishment at Thaon, the textile factory of D. Water-Seitz at Granges, and many other industrial enterprises in different parts of France.

In Belgium and Germany the zinc works "Vieille-Montagne," the Krupp establishment at Essen, the textile factory of D. Peters & Co. at Neviges, and the industrial societies of Mulhouse and Verviers deserve particular mention. In the first-named, special attention has been paid to thrift, the creation of mutual-relief and old-age pension funds and to facilitate proprietorship of homes among workingmen. Five per cent. interest is paid upon nearly $400,000 of savings deposits; $15,000 a year on the average during twenty years have been expended for pensions, and to-day one workman out of every six in the company's employ is the owner of the house in which he lives. The beneficiary agencies at Essen, involving an enormous annual outlay, are too well known to justify describing anew. Associated industrial effort at Lyons, Mulhouse and Verviers has likewise accomplished desirable ameliorations in the condition of local wage-earners.

Mulhouse is the place where free industrial patronage originated. In 1835, M. André Koechlin, a well-known manufacturer, built near his factory thirty-six dwellings containing each two rooms and a kitchen, besides a garret, cellar and garden. They were rented to employés at extremely moderate rates upon the condition that tenants should cultivate their own gardens, would send their children to school, make a weekly deposit in the savings-bank and contribute three cents weekly to a mutual-relief fund. The beginnings of the system are thus closely associated with the amelioration of the workingman's home. Elsewhere large developments have taken place along the same lines. Investments for this purpose in important industrial centers often amount to hundreds of thousands of dollars, while sums equally generous have been advanced without interest to trustworthy employés so that they might build their own houses. Rents are always fixed at lower rates than for fairly similar accommodation in the neighborhood. Often there is such disparity that the direct, net returns to proprietors are not more than 1 or 1½ per cent.; seldom do they exceed 3 per cent. Oppressive regulations of tenancy entailing immediate ejectment in case the occupant goes on strike or quits the service of the employer rarely exist and, in the majority of instances, the houses may be purchased on long-term payments. Reversion to the original proprietor at current market rates is usually stipulated, should the owner sell out.

For ten years past the progress of private industrial philanthropy in

Germany has been slow. Change of policy on the part of the government after the issue of the late Emperor William's famous rescripts of 1881, and the growth of social democracy are responsible causes. Socialism thrives best on discontent, and a stable and well-ordered industrial population does not furnish good material for converts. Once imbued, however, with the doctrine, the laborer is taught to look askance at most agencies for promoting his welfare designed and carried on by private sources. Indeed, his instructors generally teach him to regard them only as cunningly devised bonds of servitude. The imposition of compulsory accident, sickness, and old-age insurance, even more than the growth of social democratic sentiment, has militated against the progress of private effort. The charges imposed for these purposes are so heavy that none but very wealthy concerns are able to maintain additional philanthropic agencies. I do not assume to say that the working masses as a whole have not gained by the change. I think they have, for while under the old system, a comparatively small number benefitted, universal insurance carries at least a part of the advantages to all.

On the continent we see two distinct ideas embodied in practice. The first represents human regard, spontaneous in its activity but lacking in universality. The second stands for compulsory beneficence, covering a limited range of subjects but so far as it goes broadly inclusive. There is still a third, and upon it the policy of Great Britain and the United States reposes. Almost absolute non-intervention in the private interests of the wage-earner is the principle referred to.

Each one of these three systems of industrial policy has its advantages and its drawbacks. Can a combination be formed which will work well in America? I am optimist enough to believe it to be possible. The character of our government and our industrial traditions are such that the German idea is not now applicable. I would not be surprised if compulsory labor insurance yet made the tour of the civilized world; still I think its coming to our shores will be long deferred. The combination I would suggest may be made by retaining our respect for the personal rights of employés to improve their own social condition, but to borrow so much of the continental practice as relates to affording them spontaneous help in this direction. I know I shall be told that paternalism has been tried in the United States and has failed. It deserved to fail! I am arguing not for paternalism, but for enlightened human regard. The patriarchal spirit does not dominate those agencies of welfare in continental Europe which have been already described. Participation is as voluntary as the provision is free from unworthy motive.

The mistake has been made in this country of so often attaching

compulsory or semi-compulsory conditions. You cannot make people sober, honest, or virtuous by legal enactment; no more can you directly or evasively require them to consider their own economic interests. Insisting on your operatives keeping your houses full so that your 6-per cent. rent roll may be intact, or compelling employés of railway corporations to contribute to relief funds, is from the sociological standpoint a woeful blunder. The American temperament unfailingly resents such things, and when self-assertiveness is flanked by ignorance the effects are worse. Absolute freedom alone can disarm suspicion, ignorance must disappear with objective enlightenment and intelligent appreciation will ultimately displace indifference.

It is quite proper to inquire into the motive which dictates the establishment of agencies of social improvement by continental manufacturers. Has it been purely disinterested? Is the welfare of operatives the sole object? No; social helps are a means to an end in which resides advantage to both parties. Money spent upon them brings a larger economic return than under ordinary factory methods. I do not mean so far to impugn the motives of generous employers as to insinuate that self-interest is the only motive, but I do believe that it has been a powerful incentive. Experience has taught them that industrial philanthropy wisely conceived and administered is bound to pay and they have seized hold of the abiding truth that ethical elements play a large part in economic activity. M. Aynard, one of the industrial princes of Lyons exposes the creed of this type of manufacturer when he says:

> It is an error to suppose that in social economics we can be satisfied with simple justice; that is to say, with a strict observance of what are called inexorable economic laws. . . . . These laws are only the results of experience and observation which have shown them to be the best means of developing and fructifying the field of labor. They are not inviolable in the same sense as the great physical laws of nature. If they are founded upon nature we may say what Bacon said of art, in order to apply them, "man must add himself to nature." To employ a man and a machine are two things eternally distinct in the eyes of the moral law. No fatalistic or natural and especially no economic law can justify an employer in not fulfilling his whole duty towards his help.

The economic reward comes chiefly from added efficiency and stability to labor. The élite among workingmen everywhere are endowed with ambition. We are prone to consider this too exclusively as a feature of American life. It exists in Europe as well, and in no small degree. It is in the possibility of satisfying ambitions where our advantage lies. Extended observation has shown me that the better element among workingmen is always ready to go where the best opportunity exists for realizing social aspirations. More than this, when once so situated they stay. Now labor is not everything, but it is the deter-

mining factor in industrial success. Supply of capital and good business management count for much, but labor counts also. Stability of the working population is a powerful factor in the industrial prosperity of a nation. We see its effects in the existence of such centers as Mulhouse, Lyons, Roubaix, Geneva, Leipsic, Essen, Creusot, and other places where inherited skill guarantees continued ascendancy. Stability in these days of facile transportation and awakening democracy presupposes fair wages and favorable environment, it by no means connotes industrial serfdom. Experience shows us also that out of the ranks of employés of one generation come many a superintendent and employer in the next. "In Europe?" I can imagine some one saying. Yes, in Europe. I have personally come across a host of such cases. Ambition and skill can everywhere create industrial opportunity and utilize it to advantage.

We must make a distinction between stability of labor and immobility of labor. The first is voluntary, the second involuntary. The former refers to the highest class, the latter to the lower masses. Because immobility is from force of circumstances such as inferior intelligence, low standard of existence, lack of organization and the pressure of over-population more characteristic of the old world than of the new, popular opinion is grounded on false inferences. In an exaggerated fear of enthralment American workingmen, have, speaking generally, become far too migratory for their own good and for that of their employers. Such practices explain why, with immensely higher earnings, savings are relatively less. They militate especially against national opportunity to establish a reputation in the higher and finer grades of manufacture.

Stability of labor is favorably affected by an employer exercising a wholesome interest in the social improvement of his help. This fact is proved beyond question by the experience of some of the important continental establishments already mentioned. At Blanzy, out of 5182 work people, over 20 per cent. have been in the employ of the corporation for over twenty years. Nearly 6 per cent. have seen more than thirty years of service. At Creusot, 4061 out of 12,338 helpers have been continuously employed for over twenty years, 2851 for over twenty-five years and 1491 for more than thirty years. At St. Gobain and Chauny 46 per cent. of the 2234 employés have had their names on the pay-roll for over ten years and 10 per cent. for over thirty years. The director-general of the "Vieille Montagne" company which has its mines and zinc foundries in Belgium, France, Germany, and Sweden, sums up in an interesting way the results of his administrative policy:

> First of all, from the social point of view have we obtained harmony, amongst all who by their labor coöperate in the common work, have we realized that ideal social

peace of which economists and statesmen dream? We dare not affirm that perfect order has been definitely created and that our helpers have already attained that degree of moral superiority. What we can show is that up to the present, notwithstanding the diversity of countries and the variety of industries *we have never had a strike* and that a remarkable stability of labor has been attained. The average duration of employment for 6500 men is over twelve years. These facts find their natural explanation in the advantages accorded to the working people—good wages, participation in industrial benefits, facilities for thrift and the acquisition of property, security for the future through the establishment of sick-funds and a pension system. Over 900 depositors in the savings-banks, over 1000 working men living in their own houses,—acontingent of the élite wedded to the cause of order, of labor and of peace—these are the consequences! But it is very important to state also that money spent in this way has in no wise detracted from the financial prosperity of the company. If the "Vieille Montagne" corporation has been able to give its shareholders annually a dividend of 20 per cent. on the value of their original investments . . . . the credit for this is due to the liberality with which the management has treated workers of every grade.

The workingman's fear of industrial anchorage is a grave mistake. Stability is an important element in his personal welfare. Frequent changes of employment encourage restless, roving habits and involve a serious waste of gainful opportunity. They check the acquisition of a modest patrimony which is the basis of social betterment. In times of financial depression the difference between the two classes of laborers is made strikingly apparent. The settled employé with his little hoard is able generally to tide over the interim and is gladly received into the factory on the earliest resumption of work. The other class at best subsist and are compelled after each move practically to start life anew. There need be no fear of economic slavery. American workingmen are sufficiently well organized and jealous of their *amour propre* to render abortive any attempt to create industrial serfdom. So also is compulsion, whether mild or arbitrary, foredoomed to failure, while spurious philanthropy is easily detected and receives its just deserts.

But if the workingman's interest lies along the line of stability the employer's does also in even greater degree. A well-paid, contented, socially ambitious body of laboring people is *the* effectual guarantee of prosperity. Every incentive to skill, every avenue of improvement, every bond of attachment which can be created redound to the mutual benefit of work-provider and wage-earner. The principle of spontaneous patronal intervention is a good one, but practical efforts will surely be impotent unless based on human regard and fellowship. They must be free from the slightest taint of charity and be limited by the boundaries of the Golden Rule. The conditions of industrial activity differ greatly in America and Europe. We cannot feel sure that what works well over sea can be effectively reproduced on this side. Still that is no valid agument against a trial.

HISTORICAL ARCHITECTURE IN CURRENT USE.

By Prof. Wm. Henry Goodyear.

THE object of this paper is to call attention to a fact in the history of modern architectural styles which is constantly overlooked by architects, as not being historians and generally ignored by historians, as not being architects. This fact has a bearing of great importance on the problems of modern taste in architecture—both on the problem of its possible improvement and of its actually rather chaotic condition at present writing. The fact to which I allude is that the modern conception of style in architecture as at present ruling taste, has its origin in the history of literature and literary influence. It is not a conception based on the philosophy and history of architecture as such. When this fact has been explicitly made known and its phases explained, the question arises, how far has literary taste a right to govern architecture, and how far does our architecture suffer because literature does govern or has governed it? I shall address myself to these questions after developing the fact.

The most talented lecturer whom I have ever known (an English coin expert, Professor R. S. Poole, of the British Museum) makes it his openly professed rule "always to lecture to the most ignorant person in his audience." I think we may on the same principle fairly accuse modern taste of any pronounced error which is habitually common to average people. As writers and expounders and would-be prophets of reform we do not address ourselves to the most advanced knowledge, but rather to the more retrograde taste of our day. We cannot expect modern architecture to be lifted to a pitch of perfection by a few men of dazzling genius, or modern taste to be revolutionized by the assertion of correct principles on the part of a few supremely well-equipped critics. I shall therefore feel myself privileged to describe as an error of modern taste at large an error which is very constantly committed by ordinary every-day people. It may or may not be an error constantly committed by architects or one for which they are generally to blame, but it is undoubtedly an error of their average patrons. This error is that of supposing that it is the aim of modern architecture to represent, at least in its more pretentious and important examples, one or other of a series of so-called historic styles.

In my own experience I am constantly asked by every-day people to what "style" this or that building belongs. This question evi-

dently implies the belief that the building must belong to some style or other. Another question with which I am quite familiar is: "Is such a building correct in style?"—a question which evidently implies the idea that buildings are to be judged by the fidelity with which they copy a style. There are even cases where it appears that the client of an architect is advised that this or that arrangement which the client's wishes call for, must be abandoned because the "style" in which the building has been planned does not allow it. Clearly then the idea of style has a very strong hold on average modern conceptions of modern architecture.

When we take the case of more highly educated critics and of professional experts we meet the same prejudice expressed in a more subtle way. These gentlemen will suavely yield the point that a building is bound to represent its own uses and character and will delicately let you know that they are not absolutely ignorant of the principle of truth in the exhibition of construction, but they will also point out that the experience of centuries is not to be lightly neglected, that according to this experience buildings have fallen into certain types or orders, that the neglect of these types tends to license and encourage extravagant, arbitrary and eccentric designs, and that consequently on the whole it is best to stick to the styles as representing a concrete experience which it is really impossible to materially better. Given such a well-educated defender of the ideal of architectural style for modern building, it may be that when you turn the question to the position of Heine in the Romantic School, it will appear that he does not care for German. If the conversation falls on Byron's relations to the Philhellenic movement it will probably turn out that the well-educated critic prefers Wordsworth. If Milton is the topic he will probably be skeptical of the fact that Paradise Lost is borrowed from a Dutch epic. The well-educated defender of modern architectural styles is not generally very strong on the history of literature. Consequently it is natural that he should ignore the influence of the Romantic School on the modern Gothic, that he should not appreciate the influence of the Philhellenic movement on the revival of Greek architecture and that the relations of the Dutch to the style of Queen Anne should have more or less escaped his notice. Such relations of modern literature to modern architecture I shall briefly mention a little later.

Having tried in my own way to do justice to the opinions of people with whom I disagree, and having said that I consider these opinions to be the dry-rot of modern architectural taste or the cause of its dry-rot, I will proceed to state my own positions as follows:

No style ever has been or ever will be truly revived or copied. To imitate the shape of a historic building is not to revive a style. To

imitate the detail of a historic building is not to revive a style. To imitate both shape and detail of a historic building is not to revive a style.

The position of the expert, as just given, who explains why it is best to follow the historic styles is a position taken after the fact. The reasons offered for the action are not the reasons which cause it to be taken, consequently they are not the proper reasons to offer.

The average defender of historic styles in modern architecture is not very keenly alive to the deficiencies of modern architecture when it is defective; he is not very keenly alive to the virtues of a modern building when it has virtues; he is not a very good authority on, or critic of historic architecture.

The most extravagant, arbitrary and eccentric designs in modern architecture are those which pretend to follow the historic styles, not those which deviate from them.

II.

I shall open up my general argument by asking my readers to consider what was the one essential feature of a style in historic architecture, the one fact common to all historic styles. Was it not that nothing else was done at the same time in a different style? At a given time only one style was practiced. When this style was displaced there was undoubtedly a movement of transition, the movement may have begun in one country sooner than it began in another, but this movement was in one given direction. At its close a new style had absolutely displaced the former and the rule of the latter was again supreme as the rule of the former had been.

I shall ask in the next place, By what conditions are our perceptions of the existence of a style determined? The answer is, according to my view, that our perceptions are determined by conditions similar to those which cause us to distinguish between a Caucasian, a Negro, and a Mongolian. The individual variations within each type are infinitely varied, but certain general resemblances so dominate the type that we always recognize it. The difference between architecture and races is that, whereas anthropologists are well agreed that natural causes must have occasioned the difference of race, they are ignorant as to what these natural causes have been. On the other hand, in architecture, we are able to explain the historic conditions by which the historic type and the changes of historic type have been produced in the historic examples. As far as the Greeks are concerned we are able now to specify the modes of evolution in their ornamental forms, the general facts explaining the evolution of their construction, and the general correspondences between their civilization and charac-

ter and their buildings. We are again clear as to how the Roman came to modify Greek art and as to why he came to adopt it. Once more the history of medieval styles from early Christian to Romanesque and from Romanesque to Gothic is an open book to us. The gradual changes of construction, the original borrowing and gradual evolution of the attendant ornament are again perfectly well understood.

Now what is the difference with the same so-called styles in nineteenth century architecture? First, aside from our continuation of the Renaissance revival of Roman ornament, none of our styles are traditional. There is a complete chasm between the historic examples and the modern copy, covering anywhere from three to twenty-three centuries. Second, no traits of modern character or modern civilization, as such, and no conditions of modern construction can be alleged to explain the cause of revival. Third, the nineteenth century exhibits on one street or during one year a mixed conglomeration of various styles, so-called, whereas in historic examples every other example from the same century or from the same country in the same century would belong to one and the same style.

The above differences may be called general differences between the historic styles and the modern revivals generally and philosophically considered. Are there any differences as regards an individual building?

Let us ask the question first regarding the modern copy of a Greek temple. Will the archæologist of the year 2800 be able to distinguish between the Greek temple of the year 1800 A. D. and the Greek temple of the year 450 B. C.? Undoubtedly he will. First, suppose a ruin in which something of the interior of the 1800 A. D. "temple" is preserved. The interiors of our Greek temple buildings, having been made not for Greek temple worship but for banks, churches and the like, there is not one ghostly resemblance between the modern interior and that which specifies an original Greek ruin. Next, as to exteriors. Leaving out of view the stucco and timber imitations which will have disappeared long before the year 2800, we will suppose the future archæologist fortunate enough to find a real stone imitation of the year 1800 or later. He will look first for vestiges of color and will find none, such as prove that the original Greek temples were decorated in bright colors. He will next look for curves in the main horizontal lines, leans in the perpendiculars, variations in size of apparently corresponding details and in apparently corresponding distances—in fact for the whole delicate system of symmetrophobia which distinguishes the masonry of a Greek temple and he will find none of these things. Finally in place of the copy of the temple form

proper, rarely but sometimes found in nineteenth century examples, he will find generally an exterior shape which will prove to him that the building was a museum or a city hall of the nineteenth century and not a temple of the fifth century B. C. Moreover he will find a block distant a contemporary ruin of a Gothic church which by various shams and eccentricities will show him that he has unearthed the ruins of the century of shams and eccentricities, viz.: the nineteenth century.

Suppose for instance that our archæologist should stumble on the ruin of St. Patrick's Cathedral in New York. He will instantly specify its century as against any preceding one by the remains of a cement vaulting. If he should be digging up the remains of Grace Church it is not likely that he will find any remains of a lath and plaster vaulting because that will have entirely decayed, but he will find in the absence of a genuine vaulting a very significant pointer for his period. Finally if he examines the carved details of Grace Church or St. Patrick's Cathedral he will notice them to have the perfunctory, so-much-a-dozen, style of nineteenth century Gothic carvings and his date will be fixed forthwith.

We will next suppose that the archæologist of the future stumbles on a Renaissance revival of Roman style. Here he will be governed first by the use and character of the building. If he should dig up a mansion or dwelling house he will instantly specify the sham by remembering that the Roman never decorated a mansion or a dwelling house by exterior architectural ornaments. The same will hold for a shop. Otherwise the Renaissance period has never built an amphitheatre, a temple, or a basilica, and the type of the building as regards use will determine its period. We will not however assume that our archæologist will be such a mole that he would not at the first glance distinguish the massive power of Roman masonry and the elastic vigor of its decorative detail from the very best imitations ever made after it.

If our assumed archæologist of the future should be comparing nineteenth century Romanesque with the original he would be guided by similar clews. Given a church he would know the nineteenth century example by its not having a vaulting, or by the fact that its stone detail had the appearance of wood carving done in stone. Given a Romanesqe store or a Romanesque sky-scraper he would be controlled by his knowledge that the old Romanesque did not decorate its stores and did not build any sky-scrapers.

I will now proceed to define style as that quality by which we distinguish the counterfeit from the genuine article, and will then return to my assertion that we have no styles in the nineteenth century which are like the historic styles supposed to be copied.

III.

What I am trying to say so far is this—that the whole question of styles in nineteenth century architecture receives altogether too much attention and takes too high a place in our attitude to the subject.

When we compare our own buildings of any so-called style with any supposed original, the resemblances are so slight that they are not worth mentioning, and the differences are so great and so fundamental that the naming by any given style is a most unfortunate misnomer. No doubt we have a style of our own, in the sense in which old centuries had theirs, that is in the sense that to an outsider of any other century our buildings will have general resemblances and general traits by which the outsider will be able to date them. This is all that style amounts to anyway, *as style*. But in so far as we turn out with later judges to have a style it will be one of our own and not some other fellow's, and in just so far all our own pretensions and efforts in the way of imitating other styles will appear as failures and abortions.

The grand difficulty with all the cant about style in modern building is that it relates to details and ornaments, not to whole character and general construction. Go down Broadway and your modern critic will tell you that one insurance building is Renaissance and that another one is Romanesque. The critic of the future will disdain and flout this distinction. He will show you that the detail of both these buildings is essentially alike in lacking effect at a distance, he will show you that in both cases the detail lacks sparkle, imagination, and mystery. He will then lead you to a museum and will show you that these styles of detail were both copied from historic sources and that both were failures in execution because both were copies in design. As between the ornamental details of the various historic styles there is very little to choose, as regards modern use. All had a virtue which the modern copy lacks, and this virtue which all had, is so superior to the virtue which one may have as against another, that the labor of giving a name to the copy is not worth taking, when that virtue disappears.

According to my view the only question worth discussing as between modern styles, so-called, is the question as to which one has the least misapplied ornament and as to which one gives the greatest amount of restful quiet surface and of strong shadow contrast. On these heads modern Romanesque and modern Italian Gothic and so-called Queen Anne are the potential superiors.

Otherwise the only question worth discussing as between modern styles so-called, is the question as to which one exhibits the most vigorous detail. On this head the decision falls the same way in favor of the so-called styles just named, but for a reason of great importance,

viz., that these styles, so-called, being the last practiced in our century are the ones on which the general revival of art taste visible at this time has been enabled to display itself.

It appears to me after these remarks that the well-educated advocate of historic styles in modern architecture is a pretended advocate of tradition where none really exists and that he overlooks several points obvious to his opponent. To argue that indifference to historic examples opens the way to eccentricity and extravagance is trying to shut a stable door through which the horse passed a good while ago. To argue in favor of the historic styles is to forget that we fail to reproduce the virtues of any which we copy. The height of absurdity is reached when we take the part of one style as against another. The only question to be asked on this head is: "What part of our century has generally done the best in architecture?" My answer is, in spite of some misgivings, in favor of the latest part of our century. The decision will then fall in favor of the styles, so-called, which happened to be in favor at that time. According to this way of looking at the matter my preference would rest with Romanesque, Italian Gothic, and Queen Anne as having been most done when our taste was at the best. If the question be asked when has Renaissance been done best in our century? I answer, it has never been done very well in our century. Romanesque, Italian Gothic and Queen Anne pretend to be styles but do not pretend very much, therefore they are better than the others which have pretended more.

IV.

My position so far then is this—always antagonizing the well-educated partisan of historic styles in modern architecture—that the appeal to the necessity of tradition in architecture is well put, but that no one wants to dispute it. By tradition we understand continuity, the possibility of change when needed or desired and dependence on the immediately preceding past otherwise.

By tradition I do not understand that of the Greeks or of the Middle Ages. I understand the tradition of 1893 as against 1894, with the possibility of changing that tradition if needed or desired. Now what does the tradition of 1893 show us? Taken in a large sense it shows us a vast amount of historic details of various periods in modern use, all of which may be used as suggestions for a continued modern work and all of which are beautiful according to the talent of the artist who carves them. I will not at all admit that they are beautiful according to the talent of the designer, who stands unhappily behind the artisan of our day as contrasted with the artisan of the past, who was his own designer. As far as detail is concerned there is not the

choice of the toss of a copper between Renaissance and Byzantine. The question of detail concerns the talent of the artisan carver. So far then historic styles are not worth debating. The archæologist may be interested in pointing out that the artisan or suggesting designer has gone to this or that source of suggestion, but I cannot conceive that the public is called upon to believe that it has witnessed the revival of a historic style; because nothing of the kind has really taken place. Passing by ornament we will next admit the value of tradition in the matter of construction, but still insisting that in 1894 it is the tradition of 1893 and not that of B. C. 450 or A. D. 1400 which is in question. Now when we come to the matter of construction we have a case for constructors to decide. All authorities agree that the frank exhibition of visible construction and that the ideal or indirect suggestion of invisible construction control the laws of taste in architecture. The question which the well-educated partisan of historic styles has to settle just here, is how far the tradition of 1893 calls for the construction of B. C. 450 or A. D. 1400. We will leave him to agonize over this question and if necessary to write an article about it.

V.

My argument has so far been mainly to show that the supposed differences between different styles in modern use are not worth debating (or naming by the general public)—that the nineteenth century must really have a style of its own of whose character we are just as blissfully unconscious as we are of the reason why an American is always recognized in the streets of London; and whose style or character will be just as certainly visible to future generations as the style of an American is now visible to a European.

But I began this article by saying that the modern conception of style in architecture, as at present ruling taste, has its origin in the history of literature and literary influence. I also noted that the fact is constantly overlooked by architects, because they are not historians and constantly overlooked by historians because they are not architects.

Would it not be well for architects and architectural critics to study a little more closely the causes which have led to the jumble of historic styles which are now being ostensibly reproduced. If the general public could be more widely informed on this point it certainly would tend to shatter their absurd reverence for the modern habit of pretending to reproduce historic style. Let us give a few minutes to laying bare the sequence of events, which has its own logic and which carries its own explanation, when this sequence is observed. It is true that our practice now appears to represent eclecticism when its whole results are considered, but this eclecticism is only the result

of a series of overlays of sequent movements, of which the earlier have survived in traditional use while the later have endeavored to supplant them. In the last few years Renaissance has again taken strong hold on fashion and fashionable practice. For its recent revival we may turn partly to mercantile explanations, its showy qualities, and undoubted cosmopolitan availability, partly to the influence of the *École des Beaux Arts* on fashionable American practice; but the essential fact is that Renaissance has never been interrupted or abandoned since it first came into use. It is the earliest of all modern styles and as such has the strongest hold on modern tradition. Its detail has undoubtedly very much improved in quite recent years as against the middle of our century or earlier, but it is essentially the direct perpetuation of the original Italian Renaissance, dating from the fifteenth and sixteenth centuries. Beside this recent continuation of Renaissance we find three so-called styles, all of recent date and all nearly contemporaneous in introduction. Queen Anne or Colonial so called is of course at bottom Renaissance also. As coming into general vogue in this country after 1876 it represents, to my thinking, in city architecture the revolt against the formalism of the earlier brown-stone front Renaissance and in country house architecture the revolt against the carpenter's detail which immediately preceded. The contemporaneous Italian Gothic and Romanesque, first generally practiced in this country after 1870, bring us to the last of a series of reactions and attempted overthrows of the traditional Italian Renaissance.

It must be remembered that the general date for these revivals in Europe will be only a few years earlier.

Italian Gothic and Romanesque were the last phase of the Medieval revival which in its first phase stuck to the Gothic, and this Gothic revival, in its very beginnings, is as recent as the year 1820 or 1825. This Gothic revival was again preceded by the Greek revival which again does not go back of the year 1760 or thereabouts. This was the earliest of the reactions against the traditional Italian Renaissance, whose continued survival down to current date we have first noticed. After this sequence of movements has been noted we shall find our clew to it in the history of modern literature.

Renaissance architecture held exclusive sway in Europe from the close of the sixteenth century till the middle of the eighteenth century because the Italians of the fifteenth and sixteenth centuries were devotees of Virgil and Pliny and the other Latin authors. Is it not a fact that Italian literary interest in Roman antiquity is what created the Renaissance style?

Is it not patent and known of all men, when they give their minds to the subject, that Greek temple architecture had exclusive hold on

the best taste of Europe in the fifty years which center about 1800 for a similar reason; namely that Homer and Herodotus and the Greek authors had usurped the pedestals of the Latin authors?

Is it not equally certain that Gothic architecture ruled Europe between 1825 and 1850 because historians and philologists had for the first time, turned their attention to this period, because novelists had followed their lead, and because Walter Scott and Goethe had made the Middle Ages fashionable in literature?

The history of modern architecture is a history of modern literature in its successive revivals and successive dependence on the learning of the Roman, 1500–1760; on the learning of the Greeks, 1760–1825; on the culture of medieval Europe 1825–1850.

There has been a sequence in historic studies and historic discovery. The latest comers in this sequence are the ancient Orientals, the Egyptians and Assyrians. These nations are now beginning to claim an interest from historians and literary students which before and after 1830, as far as popular interest goes, was reflected in Victor Hugo's "Notre Dame" or Walter Scott's "Ivanhoe" and which then centered on the history and literature of the Middle Ages. This literary movement, known in Germany as that of the Romantic School, is what produced the Gothic revival in architecture. About 1800 men of letters, in like manner, were enthusiasts for the Greek authors and the copies of Greek temples rose to meet this special interest. Before 1760 the Italians of the Renaissance had ruled Europe for two centuries with their own enthusiasms for Roman history and Latin literature and it was this which created the copy of the ornamental system of the Roman ruins.

We return now to our well-educated partisan of historic styles in modern architecture. He is a back number. He belongs to the age of literary influence on architecture without understanding its history, and without knowing that this literary influence upon architecture is dead.

If we were doing in 1890 what we did in 1850, in 1800, or in 1750, we should now be building the Vanderbilt houses like Assyrian palaces and our churches would be copies of Egyptian temples. But we have escaped this absurdity. Literature and history and would-be archæology have lost their hold on architecture, we are still surrounded by fossil survivals of the days of 1850 and 1825, both men and buildings, but these men and these buildings are only fossils. The architect of the future is an engineer.

In a succeeding paper I shall attempt to show how and why he is an engineer, and wherein the architecture of to-day is, or should be, characteristic of our own era.

ELECTRICITY IN THE IRON AND STEEL INDUSTRIES.

By D. Selby-Bigge.

AS the science of electricity has become specialized so has the public interest in its applications, and we find ourselves inquiring now—not what has electricity accomplished in its broadest applications, but how has it been adapted to special lines of work? What progress has a given industry made that it owes particularly to the assistance of electricity? What special adaptability have electrical methods to any special line of work? Such inquiries have supplanted the broader ones that preceded them, and as the broader served a useful purpose in building up the science as a whole, so may we expect the more specialized inquiries to result in like benefit in the industries to which they are more particularly directed.

One of the most interesting inquiries of this kind that has yet been publicly presented—one likely to be followed by many others—is contained in a paper recently read by Mr. D. Selby-Bigge.* In this paper he confines himself very naturally to advances made abroad in the direction outlined by the title. On this account it attracted far wider attention abroad than in the United States, but it is of no slight interest to Americans as indicating a means of comparison between foreign and American progress. Much that was said relating to the particular adaptability of electrical methods to the iron and steel industries, while it cannot be claimed to be new, is so tersely and aptly expressed that we have decided to abstract portions that will specially interest readers of this magazine.

Passing over the discussion of long distance transmission of power for the purpose of facilitating the extraction of ore from mines, a suggestion favoring the use of a portion of the waste gases from blast furnaces for the purpose of generating electric currents for this and other purposes, an enumeration of the various classes of machines required in the manufacture of iron and steel, and an allusion to their usual scattered arrangement, the substance of the following remarks are deemed of more especial interest and suggestiveness.—THE EDITOR.

It is a well-known fact that the power actually expended in performing the work on these various machines is a mere fractional part

*"Electricity as a Motive Power in the Iron and Steel Industries," before a meeting of the Iron and Steel Institute.

of that transmitted from the generating source. In those cases where the machine tools have been driven by separate engines, it has been a regular practice to provide engines with cylinders sufficiently large to compensate for any possible losses which may occur through leakage, condensation, etc. It seems generally to have been the practice in engineering works to indicate the main driving engines, but during the author's visits to some thirty or forty of the principal engineering works in this country, he has never been able to obtain indicator diagrams showing the power absorbed by steam-driven machine tools in the works. Although attention has been paid to the economy of the main engines, the question of that in the small engines driving these machine tools, and the conveyance of steam, has often been entirely overlooked, and an enormous waste has been going on in this manner for years past.

With the advent of the electric motor this condition of things was at once changed. Every electric motor may be said to be a self-indicating machine in itself, in that the power which it absorbs can be immediately detected through the readings on the ammeter and voltmeter provided in connection with the motor.

The following are results of experiments that have been recently carried out by the author, in conjunction with Mr. H. Panton, on the actual power absorbed by various machine tools in doing their work. The figures are extremely interesting, as showing the very small amount of power absorbed by the different tools when doing their work.

TABLE OF ELECTRIC MOTOR TESTS TAKEN AT THE WORKS OF MESSRS. DORMAN, LONG & CO., MIDDLESBROUGH.

Description of Machine.	Driven by Engine Capable of Indicating	Replaced by Motor Capable of Indicating	Voltage at Generator.	Voltage at Motor.	Current taken by Motor.	E. H. P. Absorbed in doing Work.
Group of machines as under—	H. P.	H. P.			Amperes.	Per Cent.
Three cold saws .... Two ending machines ..... One saw sharpening machine	27	10½	120	115	70	10.7
Troughing straightening machine	14	3½	120	118	12	1.9
Double-ended punch, punching four holes one side and one other	14	5	120	115	25	3.7
Straightening machine, all sections	14	3½	120	115	15	2.3
Straightening machine, biggest sections	16	3½	120	115	35	5.4
Cold saw, 26 inches diameter	9	3½	120	110	15–27	2.2 & 3.9

The saving in coal effected on above machine tools amounted to 30 tons per week, after the adoption of the electric system.

Having noted the uneconomical manner—as regards transmission of power—in which iron and steel works, engineering shops, ship-

building yards, etc., are usually laid out, the power actually lost in transmission through shafting, pulleys and belts, which has often been ascertained to vary between 30 and 69 per cent. of the total power transmitted, and the unavoidable losses through condensation, leaky valves, and joints in long steam pipes, a method is suggested by which these old works could be entirely remodeled so as to effect an enormous saving not only in coal consumption and wages, but in upkeep.

The first thing to be done in planning such a rehabilitation is to have as many engines indicated as possible. Where this cannot be done it would be advisable to lay down a small temporary installation of an engine and dynamo, with a motor which could be transferred from one machine to the other, in order to ascertain accurately the exact power absorbed by the machine in question. In this way an accurate opinion could be formed of the amount of power actually required for operating the different machines throughout the works.

Having arrived at the total horse-power absorbed by all the scattered and outlying machinery, it is advisable to divide this into, say, two units of power. If the total power involved is 1000 horse-power, this would mean that it would be advisable to have two units of 500 horse-power each.

The reason why so large a power is selected as unit is that in electric power installations the load diagram will be found to be of quite a different nature from that of an electric lighting station, which exhibits a more or less constant rise and fall according to the time of day, whilst the load line in an electric power station is of a very different and fluctuating nature, varying at times between a quarter and full load, half load and full load and so on. It is necessary, therefore, both for simplicity in working and for economical reasons, to have a steam dynamo capable of giving out current for at least half the installation. It would be necessary in the case of smaller units to keep them all running, even if the load was only 25 per cent. of the total, in case at any moment the load should suddenly rise. This practice has been adopted in nearly all large power installations on the Continent.

In the case of works where waste furnace gases are available, the evident site for the generating plant would be in close proximity to these furnaces, in order that the boilers of the generating plant might be fired by the waste gases, the cost of the production of the electric current being thereby reduced to a minimum. Should there be no waste furnace gas available, the generating plant should then be placed close to the main battery of boilers in the works, and if these boilers are of a pressure below 80 pounds, it will be found economical to lay down entirely new boilers of say 150 to 180 pounds pressure.

In the case of the remodeled works, the coal consumption would probably be found to be one half or even less, of what it previously was before the adoption of electricity. In all cases where new machinery is ordered for extensions or otherwise in the works, it would be preferable to embody the electric motor in the actual construction of the machine tool itself. In the case of old works, this is hardly feasible, and the next best thing to do is to drive direct by belt on the fly-wheel of the machine in question. The motor itself, in the case of machines having to start up against any sudden or heavy load, should be of the shunt-wound type, with the shunt coils permanently excited off the line.

One of the most important features in connection with electric power installations is the absolute check or control one has over the coal consumption and running expenses at the works; and where possible it is recommended that the circuits from all motors or groups of motors should be taken direct to the generating station, and that on each of these circuits a separate ammeter should be placed, to indicate the exact power taken by any of the machines at any time of the day; as on account of the self-indicating nature of electric motors a most perfect check can be kept on the running expenses of the power plant.

It is quite within the bounds of possibility that electricity may find a new opening in its application to driving the lighter class of rolling-mills. The result, as far as economy in steam consumption is concerned, would show a great saving on methods formerly employed. The saving would be arrived at in the following manner:—Instead of the present form of engine used for actuating the rollers which is necessarily of a somewhat uneconomical nature owing to the work it has to perform, and in which the cut-off is of a very imperfect character, an engine could be laid down on the most highly economical principles, working at a high pressure, with three expansions of steam, and taking not more than 1½ pounds of coal per horse-power per hour. This engine would be coupled direct to a dynamo of suitable power, and the steam dynamo generator would be kept running continuously. On each set of rollers would be directly coupled an electric motor. The switching apparatus would be worked by means of hand and foot levers, almost in identically the same manner in which the steam is shut on and off existing rolling mill engines.

An electric motor may be considered as an elastic coupling in itself, and provided that the power furnished to it is sufficient, it will revolve when the necessary torque has been obtained. The jar, however, would be furthermore reduced by mechanical methods of coupling, and no difficulty is anticipated in being able to obtain a motor which

would resist such strains as would be put upon it. The switching apparatus, however, would require carefully planning out and constructing, in order to withstand the rushes of current which would take place through the apparatus; but here again there is nothing that cannot be overcome.

Under the heading "Engineering Works and Shipbuilding Yards," a table calculated by Mr. Felix Melotte is presented showing a very interesting comparison between the efficiencies, *obtained* on a varying load, of electrical and mechanical transmission of power.

Electrical Transmission—						
Load on the engine	1000	750	500	333	250	200
Constant frictional loss	50	50	50	50	50	50
Variable electrical loss	50	27	11	4.5	2.2	1.2
Total loss in dynamo	100	77	61	54.5	52.2	51.2
Available power of dynamo	900	673	439	278.5	197.8	148.8
Efficiency, per cent.	90	89.7	87.8	83.5	79.1	74.4
Loss in conductors	18	10	4	1.7	0.8	0.5
Energy available at motor terminals	882	663	435	276.8	197	148.3
Of which, 6 per cent. frictional loss	53	53	53	53	53	53
4 per cent. variable loss	35	20	8.5	3.4	1.7	51
Total loss in motor	88	73	61.5	56.4	54.7	54
Power available	794	590	373.5	220.4	142.3	94.5
Final efficiency, per cent.	79.4	78.7	74.7	66.2	57	47.2
Mechanical Transmission—						
Load on engine	1000	750	500	333	250	200
Loss in shafting, etc	206	206	206	206	206	206
Useful effect	794	544	294	127	44	0
Final efficiency, per cent.	79.4	72.5	58.8	38.1	17.6	0

From this table it will be seen that the two systems of transmission, which at first appear to be equivalent, become very different as the load diminishes. Thus, when only one-fifth of the power is developed, electrical transmission still yields 47.2 per cent., whilst mechanical transmission has had all its power absorbed in the constant frictional loss of 206 horse-power.

In ship-building yards there are few machines that cannot be run electrically. The whole of the machinery usually found in the machine sheds, such as punching, shearing, bending machines, etc., saws, woodworking machinery, can all very easily be run by electric motors. Owing to their light and portable nature, there is a considerable opening for electric machines on board ships during construction. Electric power can be utilized with advantage for the drilling of ships' plates, temporary winch and derrick crane work. The author understands that it has also been successfully applied for planing wooden decks.

Results obtained in actual operation of electric power installations carried out in Belgium which have now been running some three years, cases in which the entire works have been actuated solely by electric power, are instructive in this connection. "One of the first, and perhaps most important, electric power installations that has been laid down in that country, is that of the National Arm Factory at

Herstal, near Liège. The plant in the first instance consisted of a 500 horse-power compound Corliss engine and multipolar dynamo combined, the armature acting as fly-wheel of the engine. The Arms Factory is solely and entirely driven by electricity derived from this one dynamo, which provides at the same time the whole means of illuminating the works. Some 2000 hands are employed, and have been dependent for over two years on the running of this one dynamo. There has been no stoppage from the day of starting the installation up till the present time. About nine months ago another 300 horse-power was put in. This, however, was not to act as reserve power, but to supply power for extensions which had been made to the factory. The steam consumption of the engine is 13 pounds of steam per indicated horse-power. The total efficiency, reckoning from the indicated horse-power of the engine, has proved itself to be 71.3 per cent.

"Following the example of the National Arm Factory, the Belgian government decided to remove all the steam-engines and boilers from the Royal Arm Factory at Liège, and to replace them by electric distribution. It was ascertained that for a certain portion of the work which, previous to the introduction of electric driving, had taken 3 tons of coal per day, this was found to have immediately come down to 900 kilograms, or less than 1 ton, for the same amount of work done."

Taking into consideration all that has been stated, it will be seen that electric power is destined in the near future to become an important factor in the iron, steel, and engineering trades. Whether applied for the purpose of long distance transmission at the mines, or for short distance transmission and concentration of power at works, great economy will be realized in wages, fuel, and upkeep, over methods hitherto employed. Old works can be remodeled with advantage, as shown in the cases of the Royal Arm Factory and the Veille Montagne Zinc Works in Belgium, and the case of Messrs. Dorman, Long & Co.'s Steel Works at Middlesbrough, and what possibilities lie open to those contemplating laying down entirely new works!

While it is probable that there is no one establishment in the United States comparable in size with the Royal and National Arm Factories now employing electricity exclusively as a motive power, it is also probable that electricity has been more generally applied here in the iron and steel industry than abroad.

In regard to the application of the electric motor to rolling mills we are likely to see Mr. Selby-Bigge's prediction verified very shortly

if it has not been already. As this application is unique, it may be well to mention it here. The installation referred to consists of a 30 K. W. motor connected direct to the rolls, the specifications requiring that it shall be capable of reversing under full load every 10 seconds. No simple shunt wound motor could meet this requirement, but the contractors feel confident that the Leonard system, upon which they are relying, will enable them to meet every demand.

Reference to electrical metal working is conspicuous by its absence in Mr. Selby-Bigge's paper. It is true that this does not properly come under the head of "electricity as a motive power," but it plays such an important part in the iron and steel industry in America, that it must needs be mentioned in this connection. In this country there are being made at this time 2,700,000 welds per annum on steel and iron wire in the utilization of shorts. On iron pipe for refrigerators, ice machinery, etc., the work done is at the rate of 360,000 welds per annum; on axles, tires and hub-bands, 144,000 welds; carriage hardware, 275,000 welds; agricultural machinery (mostly wheels), 720,000 welds; railway construction work (frogs, switches, etc.), 150,000; and on copper and brass wires (from No. ½ to No. 16 A. G.) about 3,780,000 welds. The aggregate power employed, as above, is 4000 horse-power. In addition to this, 200 horse-power is employed in the U. S. navy yards for welding purposes, and 250 horse-power for the production of electrically welded projectiles used by both army and navy.

Electric traveling cranes have come into such general use as no longer to excite remark and they have been constructed in sizes far larger than any employed abroad. For instance the English electrical journals recently described the completion of a 60-ton electric crane at the Seraing Works of the John Cockerill Co., Belgium, as probably the largest in the world. There are quite a number larger than this in use in this country, two of which—75 and 150 tons—are at the Watervliet arsenal.

We also have put into successful practice the direct application of the motor to the tool as recommended by Mr. Selby-Bigge. Noteworthy examples of this are found in the universal drilling machines in the Cramps shipyard and in the Southwark Foundry.

In our rolling mills electricity is all but universally used for illuminating purposes, and has also found many applications as a motive power. For instance, in the Homestead mills the cranes used for handling and transferring ingots as they come from the furnace are operated by electric motors, and at the Edgar Thomson Steel Works the ingots are charged into the soaking pits by the same agency.

In the navy yards the following installations have been made:

Washington, D. C., Navy yard, 100 K. W. for arc lighting and electric crane. Mare Island Navy yard, 140 K. W. for arc and incandescent lighting. Norfolk, Va., Navy yard, 280 K. W. for arc and incandescent lighting, motor service and electric welding. And there is at present under contract for the Boston navy yard, 120 K. W. for arc and incandescent lighting, and for League Island navy yard, 60 K. W. for arc and incandescent lighting, making a total for the United States navy yards of 900 K. W.

In the United States navy the total electrical capacity actually installed in all of the vessels to date is 1470 K. W., chiefly employed in incandescent lighting apparatus, for hoisting ammunition, and for search lights. One ship, the *New York*, has been supplied with an electric launch, and several ships have been equipped with the Fiske electric range finder for ascertaining ranges.

Experiments are however being conducted with a view to a much more extensive application of electric power on board ship as a substitute for steam for elevating guns, operating ventilating fans, and last, but not least, for revolving turrets. This latter application is considered the most difficult, and so far as the Bureau of Ordnance is aware has not been attempted elsewhere than in the experiments recently tried by them at Philadelphia.

Thus while we probably find the application of electricity in the iron and steel industry in the United States nowhere quite so complete as in the instances cited by Mr. Selby-Bigge, we find it making enormous strides in every direction, having made some important conquests here that it has not made abroad.—THE EDITOR.

THE ARMOR-PLATE QUESTION—1894.

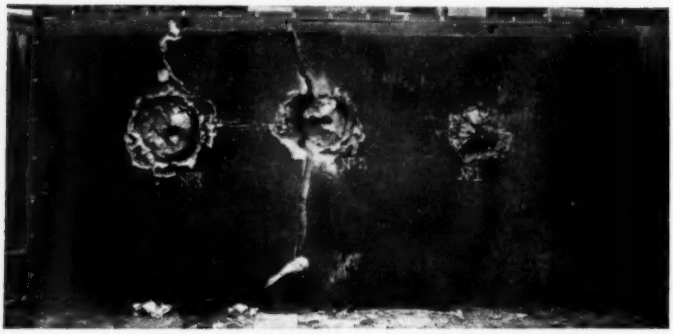
By Captain W. H. Jaques.

EXPERIMENTATION, criticism, competition and rivalry have caused a development in the armor-plate industry of unusual rapidity and energy. To such an extent, in fact, that a book could easily be written on what has occurred within the last twelve months in the United States alone, while our successes here have spurred the foreign makers and governments to an interest in this question they have never displayed before. While it is impossible in a magazine article to illustrate or describe all the results of the service and experimental tests that have taken place since the publication of Ensign Dashiell's article in THE ENGINEERING MAGAZINE for September, 1893, a sufficient number of illustrations have been collected to give the general reader an idea of the progress in armor production and to present information that will be of use to the technical student.

The British makers have given up the compound type to which they so tenaciously held, and all the European manufacturers of armor have adopted the the carbonized all-steel, using more or less carbonization or surface hardening in accordance with their own special views, and employing a variety of methods to secure the surface hardening. Great Britain has acknowledged our supremacy in the armor question and partially imitated our methods: but, for some reason not yet publicly explained, the employment of nickel in armor has been officially announced as an unnecessary increase in the cost of its production. Considering the benefits that its use has demonstrated in steel for many other purposes as well as armor, it is difficult to accept this decision on the part of the British admiralty.

The review of the past two years shows wonderful progress in this country and up to the time when I severed my connection with the Bethlehem Company that corporation had succeeded in obtaining the best record. Although statements may be repeated here, they have been employed to complete the description of the situation at the end of the year 1894. A few plates remain to be tested which may throw additional light upon some of the complex questions, but it is not probable that any more very thick armor will be tried before 1895.

The tests which have excited the most interest and carried with them the most commercial risk were the 17-inch and 18-inch nickel-steel carbonized armor for the battle-ships. Two 18-inch plates from Bethlehem, one 17-inch from the same company and one 17-inch from the Carnegie Company have been submitted, two passing test under



A. Bethlehem 2d 18-in. N-Steel Carbonized, "Indiana's" Side Armor.

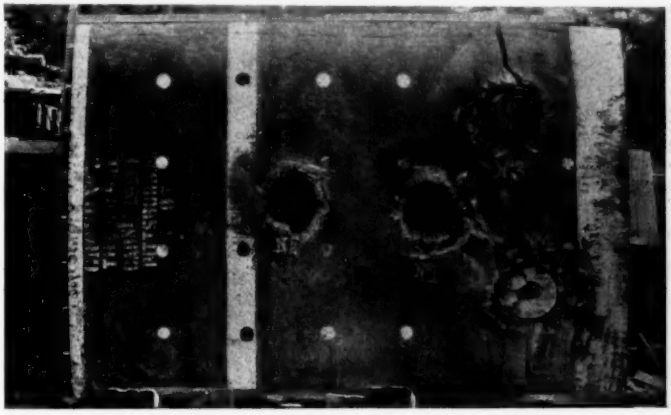
the narrowest margin, and the other two failing. One of the latter, the Carnegie 17-inch, has been accepted because of its good behavior under subsequent severe trial. All were tested with 12-inch armor-piercing projectiles. Bethlehem's first 18-inch was a taper plate* for the side armor of the *Indiana*. It was hammer-forged, sixteen feet long, 90 inches wide and 18 inches thick for 4 feet of its width from the top, tapering thence to 8 inches at the bottom edge. It weighed 33.7 tons. The plate failed under the first shot from a 12-inch pro-

* The *Engineering and Mining Journal* in its issue of May 26, 1894, gave an illustrated description of the test of this plate.

B. Bethlehem 17-in. N-Steel Carbonized, "Massachusetts" Barbettes.

jectile having a striking energy of 12,660 foot tons. The failure was due to a crack caused or developed by the Harvey treatment. The second 18-inch plate *A* barely passed the required test, the second shot cracking it seriously, although the projectile did not get through the backing. Bethlehem's 17-inch plate *B* passed the requirements; but, as usual, the plate cracked.

The Carnegie 17-inch plate did not fare so well, the narrow margin being overcome by an exceptionally good Wheeler-Sterling projectile getting through plate and backing at the second shot. The plate stood up so well after it had been subjected to the attack of two more 12-inch shells *C* that the lot it represented was accepted, and subsequently three 10-inch experimental Midvale-Holtzer (2) armor-piercing



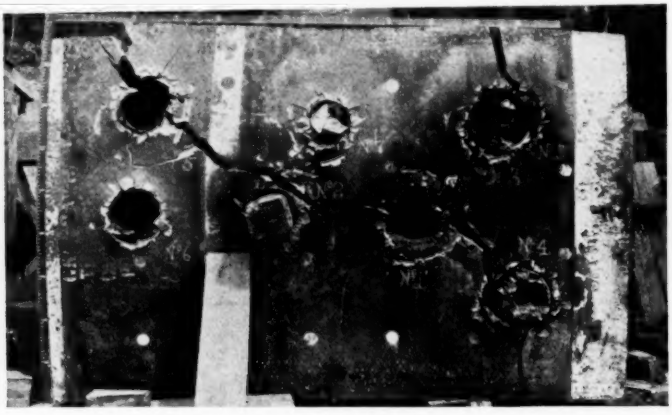
C. Carnegie 17-in. N-Steel Carbonized, "Oregon's" Barbettes.

and Johnson (1) steel cast shells fired against it increased the cracks, but no portion of it left the backing *D*.

The *Texel* trials (international) of 5.9-inch plates; the *Nettle* trials (British) of 6-inch plates, which decided the Admiralty to abandon the use of nickel; the Gavre trials of December, 1893, with 6-inch and 10-inch armor; and some experimental work at Ochta, Pola, Shoeburyness, Meppen and Witkowitz with plates varying in thickness from 6 inches to 14 inches, constitute the principal experimental work abroad. Of these, the only thick plates were presented by Vickers—12 and 14-inch—both of which cracked badly, the latter being completely perforated in addition when attacked with velocities of 1772 and 2050 foot-seconds with a 926-pounds steel projectile from the 13.4-inch B. L. rifle.

The armor exhibit at the World's Columbian Exposition at Chicago, 1893, was a valuable one, although all the makers were not represented. In addition to Bethlehem's extensive exhibit, which was installed by the writer, Krupp, of Essen, and John Brown & Co., of Sheffield, exhibited compound and steel plates of thicknesses varying from 10 to 16 inches. Schneider exhibited only a fac-simile of the celebrated nickel-steel plate which won the victory at the Annapolis tests of 1890 and some hardened gun shields, together with a very comprehensive exhibit of armor bolts and their accessories. The table on page 414 gives details of the manufacture and ballistic resistance of the three most resisting plates exhibited.

As far as the most resisting individual thick plate is concerned the



D. Same as *C* After Additional Tests.

nickel-steel carbonized armor is undoubtedly the best, and experiments on both continents show conclusively that the employment of nickel in steel is not only of great benefit to armor but also to steel used for many other war and commercial purposes; and this notwithstanding the conclusions of the British admiralty that:

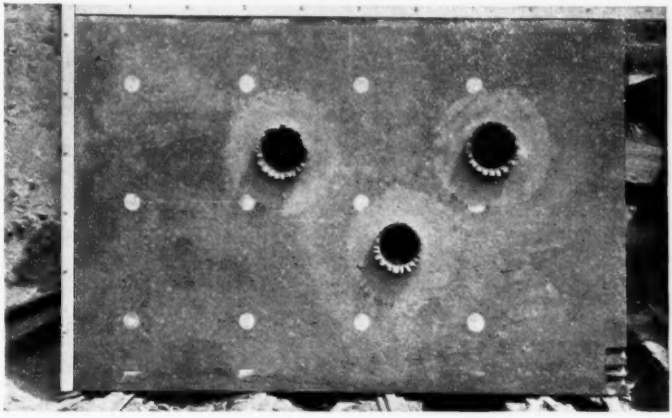
"In the course of the experiments the use of nickel as an alloy of steel for the purposes of armor plates has been fully tested. It has been established that Harveyed plates without nickel in the steel show resistance to modern projectiles as great as any hitherto obtained when nickel was combined with steel in plates also treated by the Harvey process. The consequence of adopting this new system will be a great saving in cost for a given defense."

And of Captain Orde Browne that:

"We [Great Britain] have also reason to believe that we have obtained certain distinct advantages in discarding nickel in the case of Harveyed plates. In England it has been decided not to use nickel in Harveyed plates because the resisting power against penetration is greater without nickel, although toughness is less."

The attempts to demonstrate the value of nickel in steel have been very unfortunate in England and the question naturally arises why is nickel steel so expensive as to preclude its use there? The United States steel workers have had better success with nickel than even French makers, although to Mr. Schneider, of France, belongs the credit of introducing nickel in steel.

The two facts mentioned by Mr. Ellis, managing director of



E. Carnegie 9-in. N-Steel, "Monadnock's" Side Armor.

Messrs. John Brown & Co., Sheffield, in his paper on "Recent Experiments in Armor," read before the Institution of Naval Architects, March 15th last, that "the presence of nickel causes steel to crystalize at a much lower temperature than it would otherwise," and that "the arc-light system of drilling is not applicable to plates containing a high percentage of carbon and nickel together," have, in no way interfered with our producing thick plates of carbonized nickel steel of a most attractive fine grain and fitted with as many holes and bevels on the hardened face and edges as the most exacting sailor or cabinet-maker could ask for. Further the practical evidence which the Krupp, St. Chamond, and Bethlehem 8-inch to 17-inch plates furnished as to the value of nickel in steel armor must carry great weight. Figures *E* and *F* show the remarkably uniform results that can be ob-

PLATES.

No.	Type.	Manufactured by	Country.	Dimensions.			Weight tons.	Remarks.
				Length feet.	Width feet.	Thick inches.		
1	Nickel Steel Carbonized.	The Bethlehem Iron Co.	United States.	8	6	10½	9.35	3½% nickel, medium carbon, carbonized, water chilled steel.
2	Iron & Steel Compound hard'ned, Tresidder Pr'cess	John Brown & Co. Atlas Works, Sheffield.	Great Britain.	8	6	10	8.56	⅔ iron back, ⅓ steel face. Tressider water cooled, compound iron and steel.
3	Nickel Steel Carbonized.	Krupp.	Germany.	8	6	10¼	9.06	Nickel steel, medium carbon gas (?) hardened, water chilled steel.

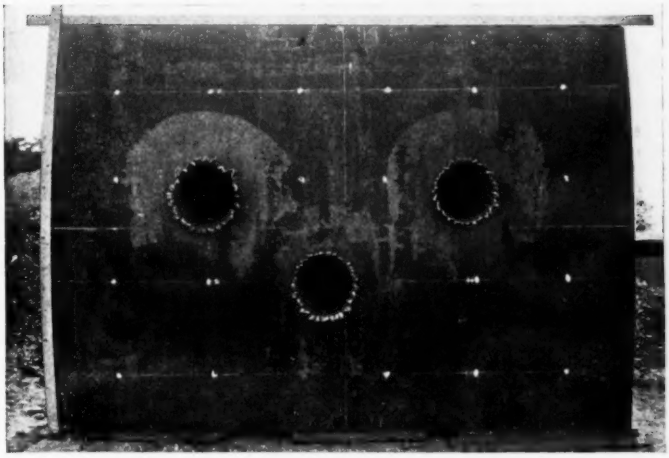
BALLISTIC TEST.

No.	Trial.		Calibre of gun inches.	Numb'r of shots.	Projectile.				Plate.			
	Date.	Place.			Type.	Weight lbs.	Striking velocity ft.-sec.	Effect on.	Penetration inches.	Cracks.	Energy. Ft. tns. per in. of plate.	Energy. Total ft.-tons.
1	July 30, 1892.	Bethlehem's Proving Ground.	8	5	Holtzer	250	1700	Points welded in plate broken into small pieces.	11.7	One slight.	542.5‡	25040
2	Aug. 4, 1892.	Shoeburyness.	6	5	Holtzer	100.7	1950	Broken into small pieces.	9.95	None.	310.1‡	13272
3	Mar. 13, 1893.	Meppen.	5.9 8.26	3 2	Krupp	112.4 307.5	2160* 1824†	Points welded in plate broken into small pieces.	12.2 ...	None.	783‡	20957

* 3 shots :—1886, 2000, 2160 ft.-secs.

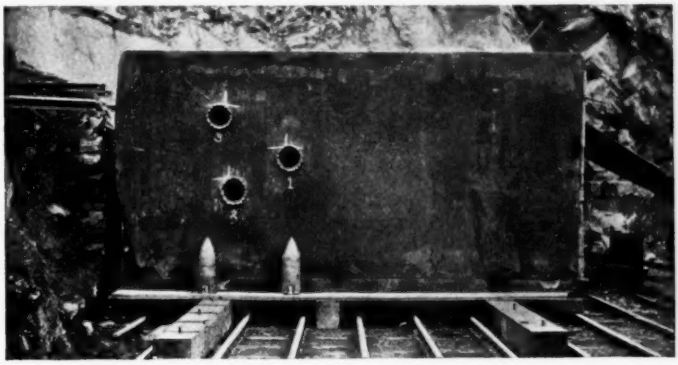
† 2 shots :—1728, 1824 ft.-secs.

‡ Single shot ; Krupp case, one of highest energy.



F. Bethlehem 17-in. N-Steel Carbonized, "Indiana's" Barbettes.

tained with nickel-steel armor. In testing the latter, it was presented for a premium, but the premium shot with a striking velocity of 2004 foot-seconds ploughed its way through the plate and backing. Other tests of nickel-steel armor of both of the companies making armor in the United States have demonstrated the admirably uniform qualities that can be obtained. Figure *E* represents a Carnegie 9 inch ballistic plate for the *Monadnock's* side armor; figure *F* a Bethlehem 17-inch ballistic plate for the *Indiana's* barbette. The trial of Bethlehem's

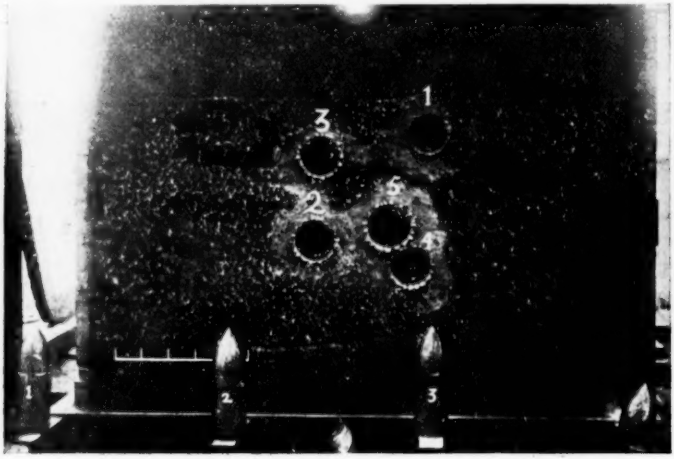


G. Bethlehem 12-in. N-Steel, "Texas" Redoubt.

H. Bethlehem 10-in. N-Steel, "Maine's" Barbette.

second 17-inch ballistic plate representing the *Indiana's* barbette armor showed the same general results as the first except that, as it cracked on the second shot, no premium shot was fired.

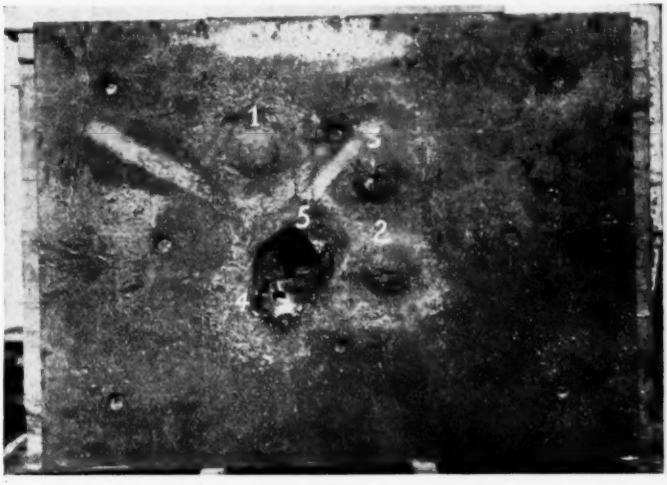
One of the characteristics to be most sought for is uniformity, and this appears to be best obtained in the nickel-steel plates. The cuts,



I. St. Chamond $5\frac{9}{16}$-in. Nickel-Chrome Steel, Front.

G and *H* showing the test-plates of the 12-inch redoubt armor for the battleship *Texas*, and the 10-inch barbettes for the *Maine* are excellent illustrations of this. Even if it cannot be obtained except at a reduction of resisting power, if this reduction is but slight, the certainty of having armor of uniform quality is an advantage. Perhaps this was why the Dutch authorities preferred the St. Chamond plate at the *Texel* trials of August, 1893.

Individual American plates still have the best record unless perhaps we except one of Krupp's, and *that* was nickel-steel supercarbonized by a process of his own. Also the best and thickest carbonized service



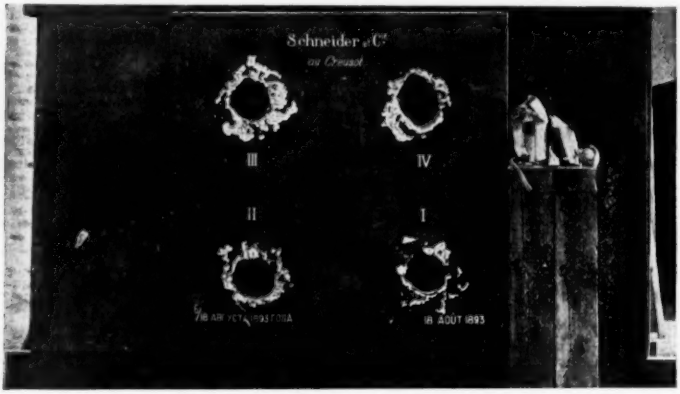
J. St. Chamond $5\frac{9}{10}$-in. Nickel-Chrome Steel, Back.

plates ever made were made in the United States and are of nickel-steel.

The *Texel* trials of August 23d and 24th, 1893, were interesting, although the dimensions of the plates were small. Brown, Cammell, Krupp, Schneider, St. Chamond and Vickers submitted plates for this trial. All were carbonized except St. Chamond's, which was nickel-chrome steel. Although the Vickers plate proved the most resisting, it was badly cracked, and the Dutch authorities preferred the St. Chamond plate *I* and *J*. I do not know that the Dutch have given to the public a reason for this decision, but a want of uniformity in the results obtained with the surface-hardened plates, their distortion in treatment and the apparent brittleness of the Vickers' sample no doubt

had much to do with the decision. Perhaps if Vickers had introduced the right proportion of nickel in the composition of his plate and the plate had been properly worked and treated he would have won on resistance and not lost on brittleness.

The benefit of carbonization has been abundantly proved, but the limit of the dimensions of the plates to which it can be advantageously applied has not been determined. Not only is the thickness of the hardened surface less in proportion to the thickness of the plate, but the larger masses of steel, when subjected to the sudden shocks of water hardening, are more liable to initiate defects or develop minor ones that may occur in the ingot, which, in the condition they exist after forging, might not sensibly decrease the ballistic resistance. Further, any minor defect that may occur before carbonization is



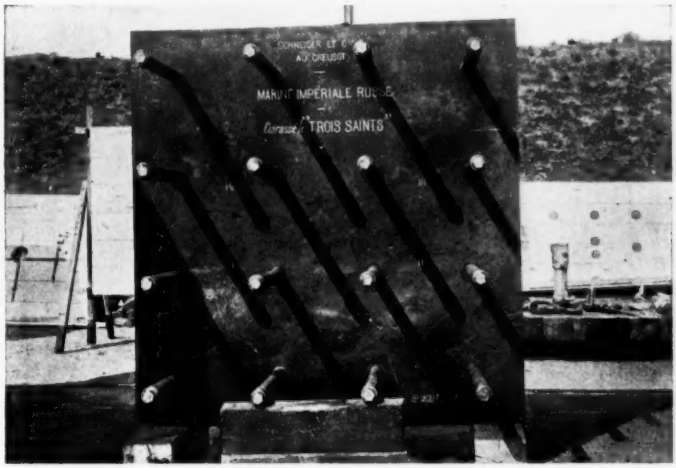
K. Schneider 16-in. Plain Steel Gas Face-Hardened, Side Armor of "Three Saints," Front.

liable to be developed into an injurious one during the very long period the plates are undergoing the process of carbonization. The difficulties of securing uniform results by the Harvey process in thick plates appear to be greater than getting a uniform distribution of the nickel and chrome in the St. Chamond type.

We will not enter here a discussion of the merits of those who have succeeded in getting their names attached to the various patented methods of surface-hardening, but hope that those who deserve it will get the pecuniary benefit. Ellis treated the first thick plate many years ago; Harvey revived this method and with the assistance of the Navy department secured patents which received attention from abroad because of the prominence our Navy department gave them. Krupp's method has not, to my knowledge, been publicly described, but the

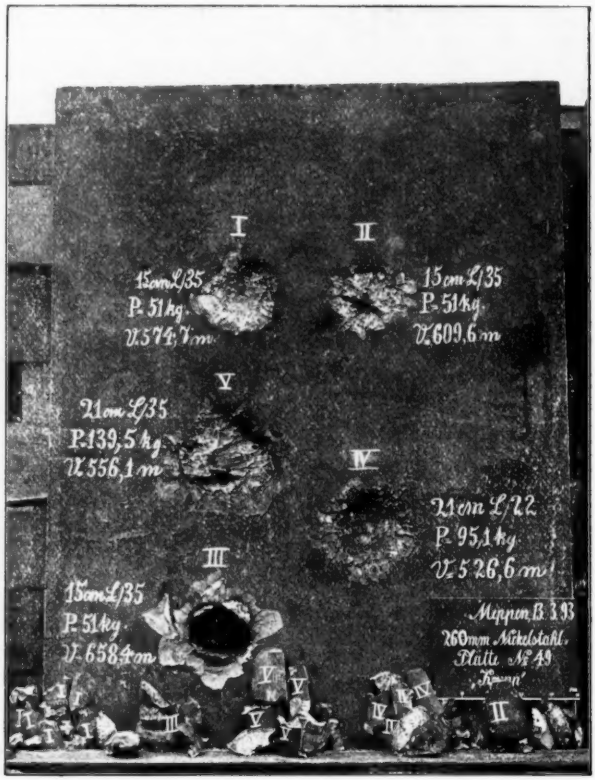
results he has obtained have equalled the best obtained elsewhere. Creusot, by the patent granted Mr. Schneider, has secured a process by which many of her successful plates have been made, while St. Chamond continues to get most excellent results with her nickel-chrome plates without running risks that the carbonization processes entail.

By far the most important tests of the year were those of the heavy carbonized nickel-steel plates for the battle-ships. Nothing was known from actual tests how these plates would act under the terrible shattering effects of the 12-inch and 13-inch masses of forged steel that have been so successfully made in the last year by the domestic as well as foreign projectile makers. The Harvey treatment for hardening their



L. Schneider 16-in. Plain Steel Gas Face-Hardened, Side Armor of "Three Saints," Back.

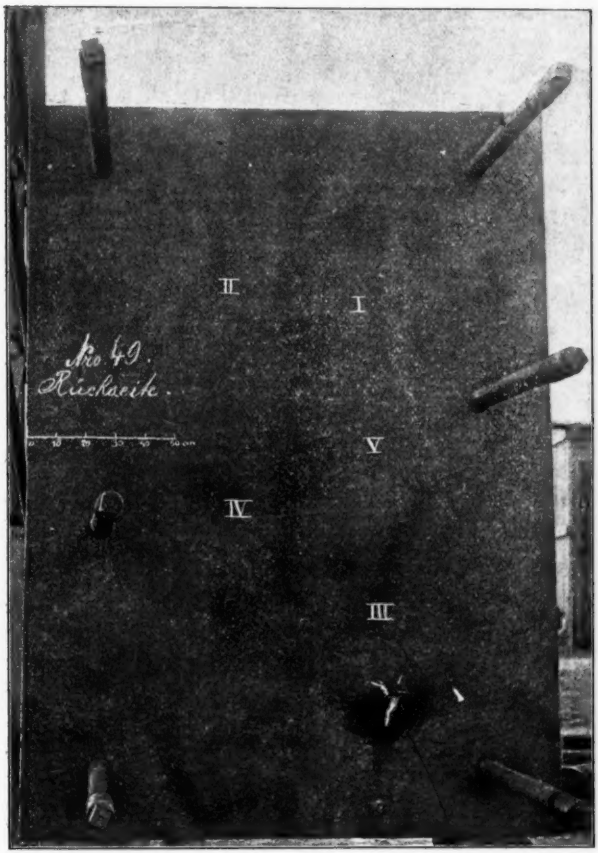
faces is so unnatural and cruel to the metal that it is not surprising that the steel resents it by setting up strains of such uncertainty that no one can tell what the plate will do when attacked at very high energies. The complicated shapes of the plates themselves add much to the difficulties of manufacture and treatment. While there are other methods of hardening armor which are probably better than the so-called Harvey process, the tests this year have by no means decided the question as to whether a slightly thicker nickel-steel plate does not present a more uniform resistance to the heavier caliber projectiles than the reduced carbonized plate. The great gain in weight however is one that cannot be fully estimated except by those who are required to find stowage



M. Krupp's 10¼-in. Nickel-Steel Carbonized Experimental, Front.

room for more coal, ammunition, provisions, etc., etc., than a ship can ever be expected to carry.

The figures *K* and *L* showing the front and back of the ballistic plate representing armor for the Russian battle-ship *Three Saints* and an experimental plate from Essen *M* and *N* give an excellent idea of what splendid results Schneider and Krupp are securing by their respective methods of carbonization. Schneider's plate had no nickel in it, but Krupp's was of nickel-steel face-hardened by a process of his own. The Schneider plate was 8 feet square and 15.92 inches thick and weighed 18.6 tons. It was attacked by four 9.4 inch Holtzer 318 pound projectiles with the following velocities :



N. Krupp's 10¼-in. Nickel-Steel Carbonized Experimental, Back.

1st	shot	2001	foot-seconds.
2d	"	1949	"
3d	"	1923	"
4th	"	1952	"

All the projectiles were kept out and the back was in excellent condition. There were no important cracks although the plate had received an aggregate energy of 33,753 foot-tons or 1814 foot-tons per ton of plate. Krupp's plate was described in the table on page 414 and shown

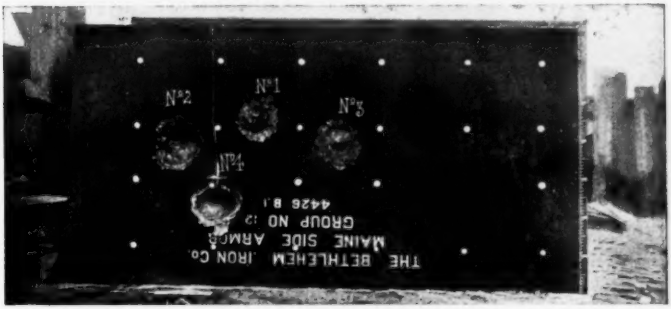
O. Bethlehem 8-in. N. Steel Carbonized, "Maine," etc., Turrets.

in *M* and *N*. Another excellent example of carbonized armor, until the cracking limit is reached, was an 8-inch plate *O* tested at Redington May 15th of this year.

It represented a lot of turret armor for the *Maine*, *Monadnock* and *Puritan*. The six-inch projectiles were completely destroyed without having any material effect, but when the plate was attacked with 8-inch service energies it was cracked in two pieces.

A Bethlehem carbonized plate, *P*, *Q* and *R* representing side armor of the barbette cruiser *Maine*, was tested at the naval proving grounds, Indian Head, October 14th of last year, and proved to be a very remarkable plate. It was tapered, of 12 inch maximum thickness, slightly curved both horizontally and vertically.

P. Bethlehem 12-in. N-Steel Carbonized, "Maine's" Side Armor After Acceptance Test.



Q. Same as P, After Two Additional 8-in. Projectile Tests.

Two shots were fired at it for acceptance.

First shot: Holtzer 8-inch was broken into small pieces, striking velocity, 1678 foot-seconds; energy, 4885 foot-tons; no cracks.

Second shot: Carpenter 8-inch was broken into small pieces; velocity 2004 foot-seconds; energy 6968 foot-tons; no cracks.

The plate having passed this test admirably, it was used for the following projectile tests:

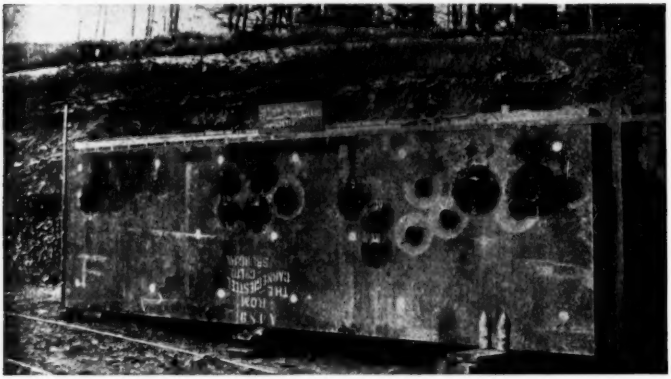
Third shot: Wheeler-Sterling 8-inch experimental blunt; broke up into small pieces; no cracks. Velocity 2004 foot-seconds; energy 6968 foot tons.

Fourth shot: Carpenter 8-inch; angular impact; broke up entirely; no cracks; velocity 2004 foot-seconds; energy 6968 foot-tons.

Fifth shot: Carpenter 10-inch angular impact; broke up, cracking plate; velocity 1977 foot-seconds; energy 13564 foot-tons.

Sixth shot: Carpenter 10-inch; normal; broke up; estimated penetration about 9 inches; velocity 1691 foot-seconds; energy 9806 foot-tons; plate again cracked.

R. Same as Q, After Two Additional 10-in. Projectile Tests.



S. Carnegie 7-in. N-Steel, Rejected on Account of Laminations.

This plate, weighing about 24 tons, was subjected to a total energy of 49159 foot-tons or 2048 per ton of plate.

It could not be perforated, but was smashed and racked by the heavier projectiles, a marked example of their value.

October 6th a similar plate representing the side armor of the *Texas* was tested at Bethlehem's proving ground. Two 8-inch Holtzer projectiles fired at 1678 and 2004 foot-seconds velocities were broken up. No 10-inch shot was fired at this plate, therefore its power to resist cracking was not demonstrated.

An examination of all these plates will discover that while they destroy the smaller projectiles they are easily cracked by the heavier ones. The type of armor desired must therefore be decided from the point of view of which is the least objectionable, *considerable penetration or cracks.*

The unfortunate complications between labor, manufacturer and officials in connection with the supply of armor by the Carnegie Company has not materially interfered with the supply for our ships. Great Britain's readers are too far away to understand the peculiar conditions, political and personal of this question. Without criticising the methods of the manufacturer or questioning the judgment of the officials, both of them, as well as the American people generally have the gratification of knowing that, as far as investigation and supplementary tests go, the United States ships are protected with better armor than the specifications called for and that these requirements are more severe than those of any other nation.

These specifications are too elaborate; the simpler they are framed the more valuable they will be, particularly if inspectors are to have

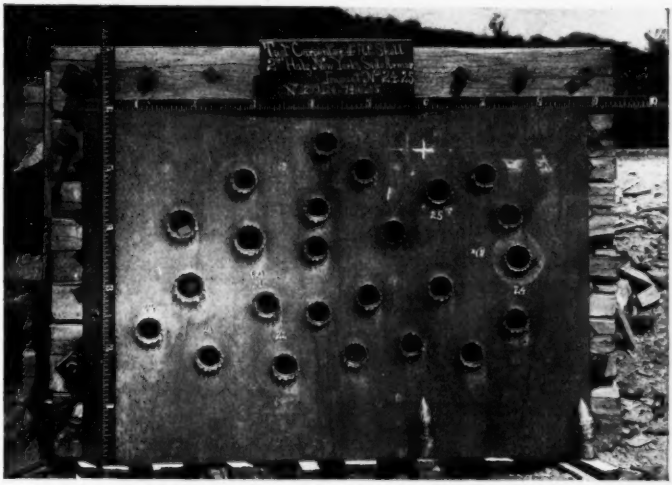
no latitude in the exercise of their duties and the system of rotation is continued. It is not at all surprising that the present system of inspection should cause friction and a desire on the part of the managers of the contracting works and practical men to follow their own methods of securing the best results.

In relation to the method of testing armor in the United States Great Britain's standard authority, Captain Orde Browne, in the *Engineer*, has said:

"In testing samples systematically for acceptance of the supply of 18-inch plates, the United States authorities are doing what has not been done in this country [Great Britain]. They have instituted a system of inspection and tests of armor which aims at a completeness and at a standard not attempted elsewhere."

This standard has not been fully met here because it was a theoretical one laid down by the authorities before any practical tests had been made of the sizes of plates that it was intended to govern. The makers, ignoring counsel to the contrary, bravely accepted the requirements and delivered some splendid products, undoubtedly the best ever made, but at the cost of some expensive failures and the discovery of the very narrow factor of safety under which they were working.

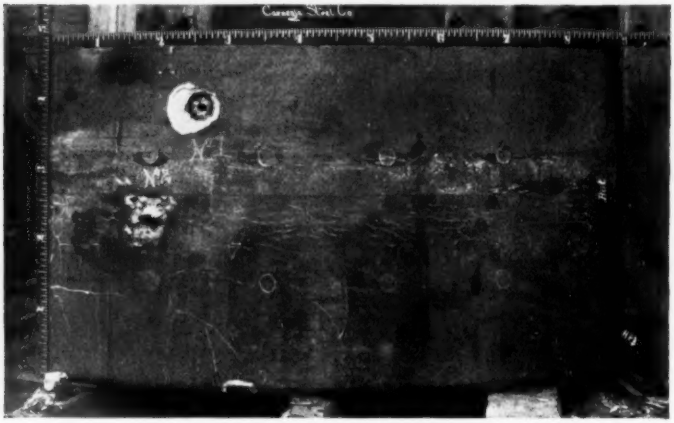
The presence of surface cracks on the hard faces of carbonized armor is not by any means an indication of a lack of resistance. This has been repeatedly shown to be true in both thick and thin plates,



T. Carnegie 4-in. N-Steel, "New York's" Side Armor.

notably in the 6-inch curved Harveyized nickel-steel plates of the Carnegie Company, the 8-inch and 10-inch plates of Bethlehem and a number of thicker plates of both makers. Carnegie's 6-inch curved Harveyized nickel-steel plate A 883,* which was rejected on account of surface cracks, kept out and destroyed two 6-inch Carpenter armor-piercing shells when fired against it with a striking velocity of 1800 foot seconds, the second shot being fired at the cracked portion. The *Terror's* plate *A* 489 *S*, manufactured by the Carnegie Company, has been shot at fourteen times, and although it was rejected on account of laminations, no cracks developed while undergoing ballistic test.

The bottom half of a plate *T* representing the *New York's* side



U. Carnegie 4-in. Curved N-Steel Carbonized.

armor, shows the result of twenty-four shots, no cracks appearing anywhere.

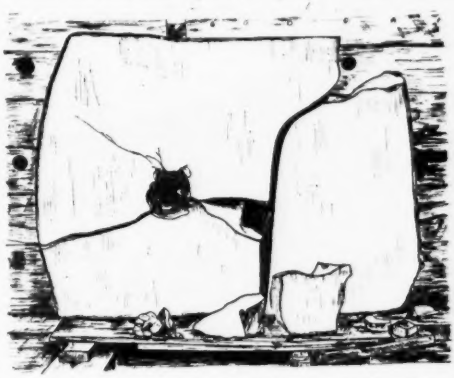
Our Navy department, however, not being fully convinced how much latitude can be given the makers in this item of surface cracks, and how much they may affect the ballistic resistance of the plate, gave particular attention to this point in the test of a 4-inch curved nickel-steel carbonized plate *U* from the Carnegie Company. Like its surface-cracked predecessors it passed the required test satisfactorily.

A careful inspection of the methods and alloys employed in the manufacture of armor in the different countries discovers results which are difficult to accept. Great Britain has decided that the additional

* The *Army and Navy Journal*, in its issue of June 23, 1894, has given an illustrated description of the test of this plate.

cost of the employment of nickel is not justified by the results; that its use causes characteristics which are injurious; but she has made no comparative tests of thick plain steel and nickel-steel, such as have specially proved in America the value of nickel in armor-steel. The inferior results that have been obtained in the United States when chrome- and nickel-chrome plates have been experimented with are also surprising. When we consider the very excellent results that Witkowitz and St. Chamond have obtained and the large quantity of excellent armor the latter has turned out where her nickel-chrome, untreated, uncarbonized armor has equalled, and in some cases surpassed, Harveyized plates, it would seem to be to the want of experience in the composition or subsequent treatment that failures must be ascribed.

The experimental nickel-chrome steel plate, Figure *V*, was manufactured by the Bethlehem Company. Its complete demolition by one 8-inch projectile would seem to indicate that something was radically wrong in its manufacture since nickel-chrome plates of approximately the same composition have not only shown most excellent results, but in two cases have beaten their competitors. I have advocated nickel-chrome armor because of the possibility of securing a very satisfactory product without the risks that Harveyizing entail in all plates, particularly in the thicker ones.

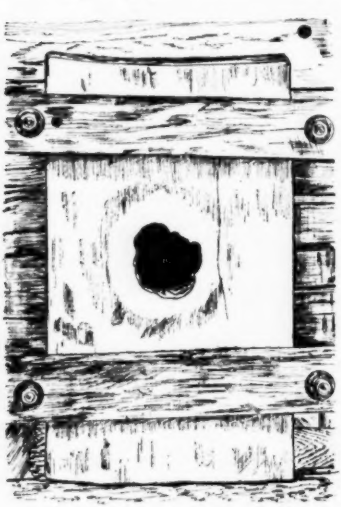


V. Bethlehem 9-in. Nickel-Chrome Steel, Experimental.

The test of thin shield plates containing alloys of chrome, nickel, and manganese, carbonized and uncarbonized, have not been productive of important results. They will no doubt be continued by the makers as well as by the Army and Navy departments, since such experimentation can be carried on at a moderate cost. A very tenacious, resisting nickel-chrome plate ought to be obtained without much difficulty, but considering the comparative ease with which thin plates can be surface-hardened, the nickel-steel carbonized plate ought to be as good as any. We have had so many tests of thin plates that we can prepare curves of resistance for them that can be almost perfectly relied

upon. Specified qualities in these thin plates ought to be as readily obtained as standard boilers or shafting.

In connection with thin plates mention must be made of the successful practice that is being obtained with our 12-inch rifled mortars. Uncarbonized alloyed metal will probably resist mortar fire as well if not better than any other type, as brittleness must be avoided as much as possible where low velocity large caliber projectiles form the attack. All of the plates thus far tried have cracked badly. Ships not especially built with armored deck protection, must regard effective mortar fire with grave apprehension. With mortar fire from above and submarine



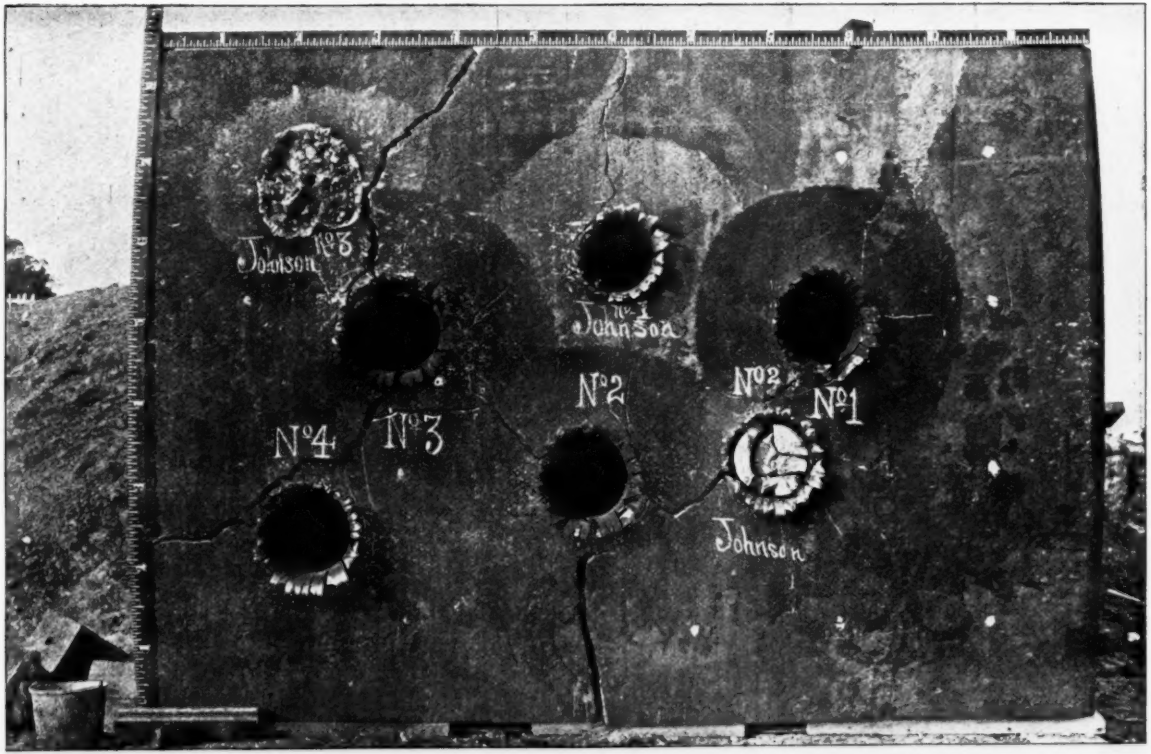
W. Hadfield 5-in. Manganese Steel, Experimental, Front.

X. Same as W. Back.

artillery from below the bravest commander will hesitate to attack a thus protected port.

In March last a slab of Hadfield manganese steel was forged into a 5-inch plate and hardened by the Bethlehem Iron Company. It was attacked with a 6-inch Holtzer armor-piercing shell at 1400 foot-seconds striking velocity. Greatly overmatched, it was completely perforated, *W* and *X*, but there were no cracks nor fringe, nor bulge. While the plate did not exhibit the resistance expected, the test furnished another demonstration of the value of manganese as a toughening agent.

Unlimited discussion continues as to the comparative value of



F. Test of Three Johnson Cast Steel Shot against "Indiana's" 17-in. N-Steel Plate.

forged and rolled thick armor. Although rolling is a type of forging, I make a distinction here because the products of the two methods have been so often compared and are productive of such different qualities. I am still of the opinion I have expressed for many years that the forged plates are more resisting and economical than the rolled ones and that the forging should be done with the hydraulic press. This view has now been practically endorsed by Bethlehem's substitution of a press for its hammer; the Carnegie Company's purchase of a Whitworth press; John Brown & Co.'s purchase of a Whitworth forging press, carrying as it does this method into the Holy See of rolling mills; England's adoption of the same method and by the prominence Continental writers are giving to the value of the hydraulic press.

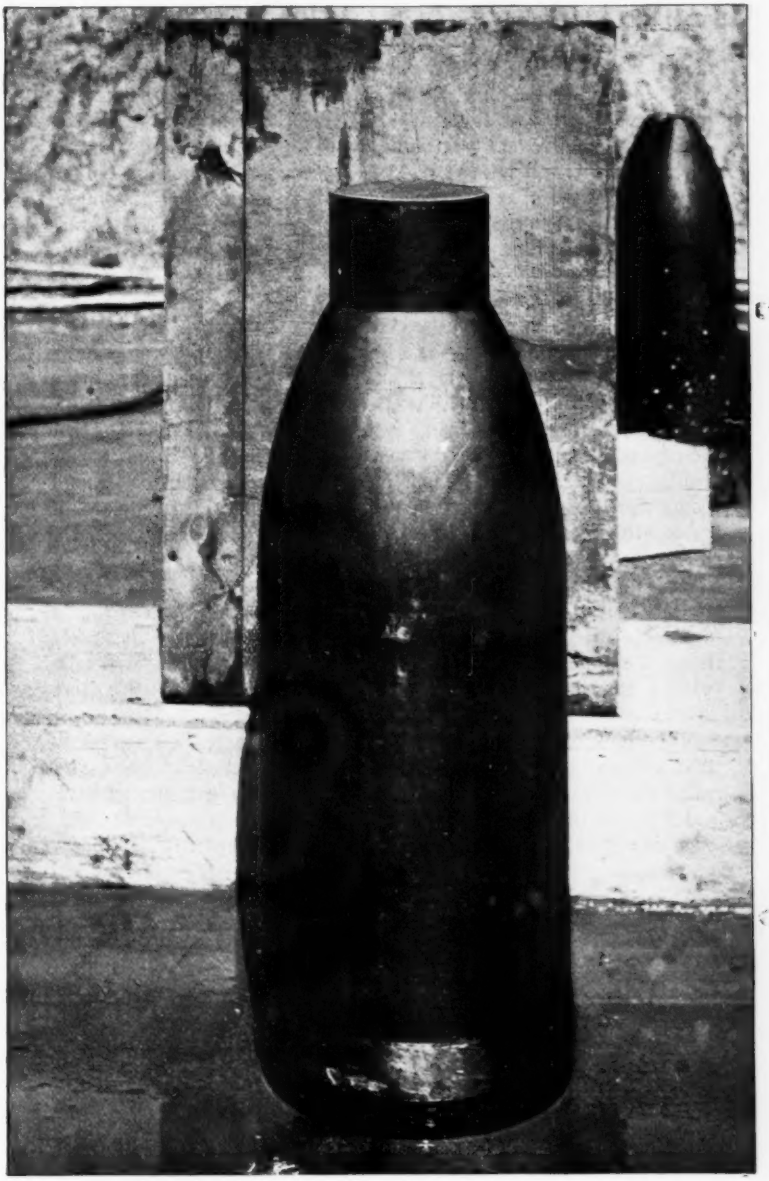
Much valuable experimentation has been done to determine the action of various characters and types of projectiles. This has led to a marked improvement in their production.

Forged chrome crucible-steel armor-piercing shells have done wonderful work while steel-cast shell and soft, patch pointed shell have succeeded in perforating carbonized steel armor *Y* when the forged ones have been readily broken up. The attempt to pierce hard faced armor by the application of a soft metal cap to the projectile has excited much attention in Russia, England and elsewhere and has been tested at our own proving ground at Indian Head with the Johnson steel-cast shell.

Our illustration *Z* shows one of the methods employed. The difficulty of attaching it securely to the point of the shell, accidents which have been caused by the cap jamming the projectile in the bore and its disadvantage when angular impact takes place have produced such uncertain results that no definite conclusion has been reached as to the efficiency of this device.

The study of the most suitable velocities for perforation, giving time for a point entrance to hard faced armor, has given data that is at least interesting if not useful enough to be accepted as final. These trials of types and calibers are of much value to the armor maker and artillerist as they assist the former to decide the character of his product and the latter the caliber of his gun, the weight of his projectile and the ballistics he must seek to obtain. Recalling the increase in the number of ships carrying only rapid-fire batteries (which now include guns of 6-inch caliber) a very valuable experiment would be to determine the comparative resistance of nickel-steel and carbonized plates of thicknesses now considered to be more than a match for rapid-fire attack. It is very desirable we should know how they will behave under such conditions.

Although repeatedly suggested, very little has been done to obtain



Z. Johnson 10-in. Cast Steel Shot with the Soft Steel Cap on.

actual remaining velocities by the use of screens behind plates in testing armor and projectiles. A large number of the latter perforate the plates and much valuable data could be obtained by their use to replace assumed arbitrary conditions and to lessen the demand upon the Greek alphabet which is so copiously drawn upon to represent the unknown quantities of ballistic equations. Not only is this true in determining the comparative resistance of plates but equally so in grading projectiles, which, in many cases, fired with high velocities, are either lost or not discovered until one of the approximate elements of value—heat – has disappeared.

The results obtained in the United States can safely be taken as a standard of what protection can be obtained with various thicknesses of armor, because more serious and numerous tests have been made with each than is the custom in other countries, notably Great Britain. Although England occasionally tests a plate of service thickness her general practice of reducing plates to a thickness of six inches for ballistic acceptance, while supplying a uniform specimen for test and comparison does not give results that will always hold true in plates of greater thickness, or be a guide for the valuation of the service plates themselves.

Lieutenant Weaver's very thorough "Notes on Armor," published in the "Journal of the U. S. Artillery," and Captain Orde Browne's articles in the London *Engineer*, and Brassey's "Annual," have followed the armor question with much care. Very many more details will be found in their series than can be brought together in this short article.

The tests of the past year have enabled us to reach conclusions that will enable our Navy department to contract for armor for its variety of purposes that will insure our getting the best, and we have again proved to our legislators that all we need is adequate financial encouragement to enable us to lead in all branches of naval architecture and ordnance engineering.

NOTE.—The writer thanks the Chief of Bureau of Ordnance, the Commanding Officer of the Naval Proving Ground, the Naval Institute, the manufacturers and others for their assistance in the preparation of the illustrations.

ECONOMY IN MACHINE SHOP MANAGEMENT.

By James Brady.

WHERE should workshop economies begin? Where should they end? The latter question is much the more easy to answer. Shop economies should never cease. To maintain them, however, in all departments, will require unremitting vigilance.

Most men in assuming the superintendence of a workshop look first into the boiler- and engine-rooms to see what is going on there. This seems to indicate a prevailing belief that these parts of a factory or machine-shop plant are those in which wastes are generally most likely to be discovered.

Indicator diagrams will probably be taken; boiler examined for scale; quality of the fuel inspected, and the manner of firing scrutinized. This is all commendable if the search for wastes does not substantially end here, as it does too often.

A superintendent, assuming a new position may reasonably expect to find more or less waste going on throughout the entire establishment of which he assumes the charge. If there had been no reason for a change as regards his predecessor, the change would not have been made. The exceptions to this would be where a vacancy has occurred through the death of the previous incumbent, or where he had resigned, having been called to a more advantageous position by reason of his known efficiency, and induced to make the change by the offer of a higher salary. And even in the case of such exceptions the new superintendent may be able to detect lapses in economies, that escaped the other, since "two heads are better than one," and he will probably look from new points of view upon what is going on.

Opportunities for economy should, therefore, be sought everywhere. Economies in the counting-room, workshop, packing-room; economies in purchases and sales; special economies that may be effected in the performance of special jobs. In short, the study of economy is the study of how to achieve success in any kind of manufacturing industry, big, or little. And unless economy includes small things it will never comprehend the large; all that is large depends upon small things.

Economy is a matter of habit, like good language, or good manners. It must be a matter of common usage or it will fail when most needed. This study should be pursued with ardor morning, noon and night. It should pervade the atmosphere of the shop, so that each man and boy shall breathe it in, and become imbued with its wholesome spirit. "A penny saved is two pence earned." "Waste not,

want not." The full meaning and import of these maxims should be absorbed by every one who does anything in a shop, from the proprietor and superintendent down to the man who sweeps up the floors, and the watchman who cares for the place nights and Sundays. And if it is not in a superintendent to inspire a wholesome degree of this spirit in the workmen under his supervision, he may be a skillful mechanic enough—a good engineer—a bright, intelligent man, but he lacks one of the most important qualifications of a superintendent.

Let it be understood at the outset that economy means the avoidance of needless wastes, not niggardness, which latter Sir Philip Sidney called a "sluttish vice." Economy is a virtue, not a vice. Economy is honorable, and has been so ever since Solomon wrote the Proverbs. "There is treasure to be desired and oil in the dwelling of the wise; but a foolish man spendeth it up." To be niggardly and parsimonious is to be mean—despicable. Niggards generally fail in true economy even when they attempt to practice it. To save the immediate penny they hazard the future pound. I advocate no such economy as this; nothing that is inconsistent with just and reasonable liberality. The economy I am speaking of is reasonable—even generous; he who is not economical can rarely afford to be generous.

It is my purpose to write more particularly of special economies in the performance of special work. My experience has compelled my attention to such economies more than usually falls to the lot of mechanical manufacturers. The kind of work with which I have occupied myself for many years is the building of new experimental machines; and thereafter, if these continue to be made to simplify and cheapen their production and manufacture them on contract.

In the construction of new machines there are usually few precedents upon which to base estimates. He who undertakes to build them at a previously estimated cost, will often be required to exercise his ingenuity to the utmost in order to effect such economy of time, tools, and material as will leave him a reasonable margin of profit. Many times I have saved myself serious losses by the adoption of entirely original methods that largely reduced cost of manufacture, and some of these will be illustrated and described, in the hope that they may afford useful hints to others. But before entering upon this part of the subject there are some general economies to be noted.

Economy of temper and worry is a most important thing to be sought by any man who conducts a manufacturing business. Of what good is a competence, or even wealth to a man with shattered nerves and ruined digestion? If a man cannot govern his temper, in a business wherein exasperating mistakes are to be expected, if he allows himself to continually worry over temporary failures and disappoint-

ments, he may perhaps amass money, but the care-furrows will be plowed too deep in his forehead to enable him to enjoy the fruits of his industry. Self-control is therefore one of the first economies to be learned in business. It saves health, happiness, and even life. Temper and worry have carried many a man to an untimely grave.

One of the means most effective in preventing worry is an easy, intelligible, exact, handy and economical system of accounting; and I early turned my attention to organizing a system that should comprise all these features. Though usually in prosperous times having a great variety of work in hand, I find the services of a single bookkeeper all that is required to keep an accurate record of all work in every one of its stages from commencement to finish, together with all general accounts needed to give a complete history of the business.

In the morning as the men file in to their work past the counting room, each is given a card or ticket. At the head of this ticket is printed one of the conditions of their employment, to the effect that all employés must assume and bear all responsibility of personal injury received while in the employ of the concern. There are also printed at the top of the ticket the statement that "all help is employed by the hour," and the injunction to enter at the end of work on any particular order in columns ruled and headed for such entries on the ticket "time and stock on the same before starting on new work." There is also a place for writing the date. On the left margin of the ticket is printed the direction never to use machines or tools that are out of repair, and in this injunction is implied one of the fundamental economies in shop practice. I need not further enlarge upon this point. On the right margin of the ticket is printed the caution "Carelessness around machinery is dangerous." Below the date line, at the top of the ticket is a line where the workman enters his name and his number, each man having been assigned a special number when engaged. The employment of numbers for men and for orders saves a deal of writing. The ticket is ruled to make four vertical columns for entries. All orders for work, whether job work, contract work, or repair work of tools and shop appliances, are each assigned a special and consecutive number when they are commenced. The first vertical column is headed "*Order No.*"—, the blank being for the numeral and the column of a width to conveniently receive a number of six figures. The second is headed "*Part No.*," which permits a special record and accounting of parts of orders to be made when this is desired, and this is often desirable in the kind of work done in many establishments. The third column of the ticket is headed "*Character of Work*" and is wide enough to admit the insertion of explanatory words; as for example, "*altering patterns of drop-pawl*;"

and the fourth column is headed "*Hours.*" In this the workman records the number of hours he devotes to any order or part of an order. There are seven horizontal lines on the ticket for writing; this number is found sufficient. A sample entry made by a workman would read as follows:

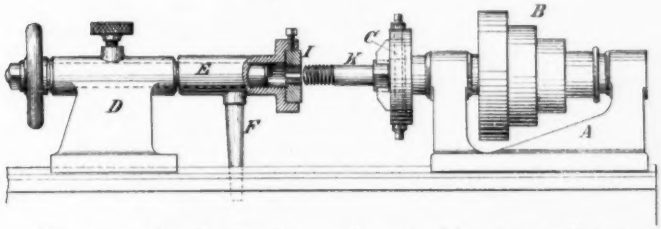
Order No.	Part No.	Character of Work.	Hours.
3451	34	Altering Drop-Slide.	8½
"	"	Stock, 3 lbs. Cold Rolled Mach.	
"	"	Steel.	

At the bottom of the ticket is printed in bold red letters the direction "*Don't fail to charge stock.*" In a final line are printed the words "*Foreman's Check,*" opposite which, at the close of the day, the foreman, examining the ticket, signifies its correctness. There is also a place for writing the total number of hours worked on the one or more jobs, with which the workman has been employed during the day. On going out at night he drops this ticket into a receptacle

It will be seen that this ticket amounts to an itemized bill rendered by the workman in his own handwriting for each day's service, and places in the bookkeeper's hands all the data necessary for keeping an exact account of any job or any part of it. The work book has columns for collecting under special order numbers the information supplied by the workmen's tickets, relating to each order, and each week a bill is rendered for each order on which work has been done, a press copy of this bill being made in the salesbook. Thenceforward the bookkeeper has to deal only with the footings of these bills, requiring only one ledger entry for total charges on any order for the week. If twenty orders were in hand, there would be twenty of these entries to post, and as the books are kept by the double entry system there would be only forty ledger entries.

On the work book provision is made for a column of totals. Each day's expenditure for labor and stock is added to the previous total, so that at the end of any day, the amount any job has cost up to that date may be at once read off. The same system applies to parts of work when their cost is desired to be ascertained. The bookkeeper first enters from the tickets the total of hours each workman has worked in the time book, which is our pay roll, opposite his number. Then this time is entered against the order numbered in the work book, with the price per hour of the labor, and a simple multiplication gives the extension which is assigned to a special column. Charges for stock are treated similarly. A system of proof sheets checks the whole system for errors, which, however, rarely occur.

FIG. 1.

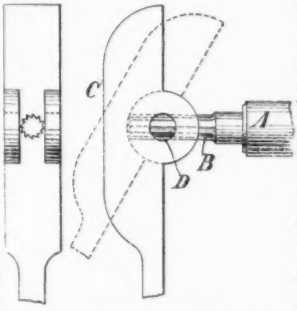


There are other details of convenience in this system, which, however, must give place to some mechanical economies which have helped out greatly in the execution of a variety of work wider perhaps than falls under the experience of most mechanical engineers.

A quick and very effective way of flattening punched blanks of brass or other ductile metal is to bunch them in lots of a dozen or more lying one upon another, and strike the bunch with a drop-hammer. Blanks may be very quickly and perfectly flattened in this way, that could only with great difficulty, if at all, be brought to the same perfection by treating them singly.

To do bolt cutting on any lathe the arrangement shown in Figure 1 may be employed. *A*, is the head stock ; *B*, cone pulleys ; *C*, chuck ; *D*, tail stock ; *E*, a sleeve fitted to slide on and over the tail stock spindle ; *F*, an arm attached to the sleeve *E* ; *I*, screw cutting die. The blanks *K* for the bolts, having been cut to desired lengths and pointed, are chucked, and being entered at the pointed end into the die the cutting is readily performed, the sleeve *E* being prevented from turning by the arm *F*, but sliding freely on the tail spindle *E*. A method of milling out the inner surfaces of what are known as rule-joints is shown in Figure 2. *A* represents the live spindle of a Brown and Sharpe milling machine. *B* is a cylindrical milling cutter, mounted in the work mounted on the spindle ; *C* is head of the machine, and so adjusted that it makes a partial revolution around the center *D*. These joints which are of frequent occurrence in certain kinds of machine construction can be rapidly, accurately and cheaply fitted by this method.

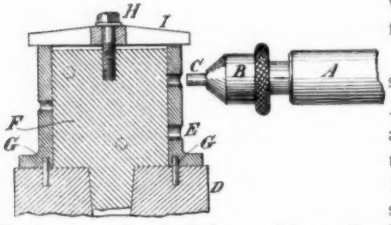
FIG. 2.



There came into my establishment at one time an order to make

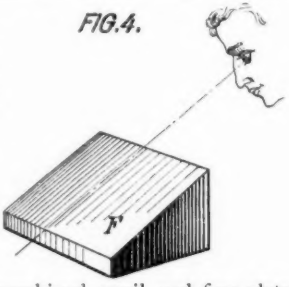
ten knitting-machine cylinders. These were hollow, and through their sides there were to be drilled a number of holes disposed in a certain way. A sample cylinder was sent with the order and the order was explicit that the holes (all of one size) must be bored and located in positions exactly the same as the sample. The expense of a jig for this work put this resource out of the question at once. Another method was resorted to which located the holes perfectly.

FIG.3.



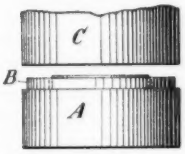
This is illustrated in the sketch, Figure 3, in which *A* represents the spindle of a Brown and Sharpe milling machine; *B*, a drill chuck; *C*, a test plug of the exact size of the holes to be drilled; *D*, the worm head of the machine; *E*, the cylinder to be drilled—shown in section and having holes at the bottom for dowel pins, *G*; *F*, a cast-iron piece made to fit the interior of the cylinders and fastened to the worm head so as to properly center the cylinders; *I*, a clamping bar which firmly held the cylinders when the screw bolt *H* fitted into *F* was tightened down. The adjustment of the pattern cylinder having been exactly made for any one of the holes so that the test plug would exactly enter it, the head was allowed to remain in the same position, the pattern cylinder and the test plug removed, the cylinder replaced by a cylinder to be bored, and the test plug by the drill, and the holes were thus exactly drilled in their required places. The dowel pins at the bottom which were all drilled in the same position relatively to one of the holes, insured the correctness of position of any hole in the horizontal plane. Of course some time was consumed in handling, but the cost of this was only a small fraction of the cost of a jig.

FIG.4.



A handy time-saving device is shown in sketch Figure 4. This is a combined anvil and face-plate having an inclined face *F*. This face is made true and may be called an inclined face-plate. It is used as an anvil in straightening pieces with a hammer and in testing pieces for straightness, and where a considerable number have to be handled, it saves a great deal of time. For example suppose a workman to be holding in one hand a piece

FIG. 5.



which he has been working upon by a tool held in the other hand; he can, without laying down the tool (file or hammer), apply the piece to the face-plate to discover defects, instead of laying down the tool, taking up a straight edge and adjusting the piece to the straight edge. In work of this kind minutes rapidly multiply into hours, and if seconds can be substituted for minutes, it is worth every man's while to do this.

The diagram, Figure 5, illustrates a method of compressing to gage brass blanks, by hydraulic force. *A* is the anvil; *B*, a ring gage; *C*, a follower. The blanks are successively placed in the gage and pressure applied. It is a much cheaper process than turning them off, and it compacts the metal so that the gears are stronger and wear better in use.

FIG. 6.

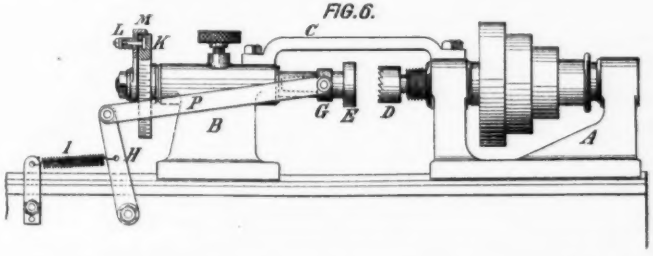


Figure 6, illustrates a method of face-milling to gage, in a lathe. *A* is the headstock; *B*, the tailstock; *C*, a stiffening brace bar; *D*, milling cutter; *E*, piece operated upon; *P*, a link pivoted to the collar *G*, and at the other end to a rock bar *H*; *I*, spring; *K*, graduated hand wheel on tailstock spindle; *L*, an adjustable stop attached to *K*, having an index finger and so set that when the spindle has advanced to the right point to gage the cutting, the end of the rock bar is brought under it, and the motion of the spindle is thus arrested. Face milling to a uniform gage can be thus performed with dispatch in a common lathe to within $\frac{1}{10,000}$ of an inch.

FIG. 7.

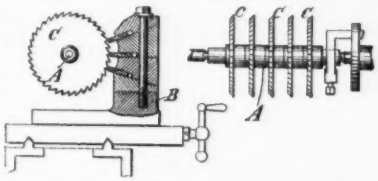
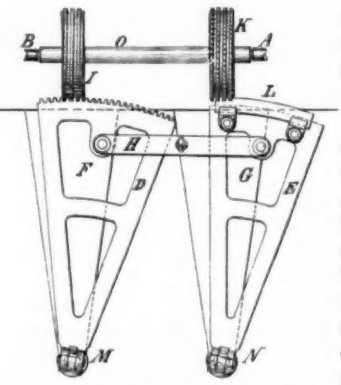


Figure 7 illustrates a method of rapid ratchet or square tooth cutting. The cutters *C* are mounted on an arbor *A* which is held in a lathe and revolves in the

usual manner. *B* is a clamping holder mounted on the carriage of the tool post and arranged to hold three pieces to be operated upon at once. I have used ten cutters in this way so that at each feed 30 teeth would be simultaneously cut. The cutters on the arbor are set at a uniform distance apart, which distance is some multiple of the pitch of the teeth to be cut in the rack. The carriage is moved along intermittently after each cut by the lead screw or a special screw worked by hand.

A method recently devised and employed by me in cutting a large number of thin segmental racks, the pitch line of which was required to be on a radius of 36″ is shown in Figure 8. *A* is the dead center and B the live center of a common lathe. On the shears of the lathe are rigidly clamped two strong triangular iron frames, *F* and *G* projecting horizontally forward. To *F* is attached a movable frame *D* by a universal joint at *M*. A similar frame *E* is connected at *N* to *G* in a similar manner. The frames *D* and *E* are connected by a link, *H*, so that one moves precisely like the other, in a horizontal plane, on ways at the front ends of the frames *D* and *E*. On the front end of E is a clamp which holds the blank sector *L* to be cut. On the front end of *D* is a toothed sector in which meshes the worm wheel *I*. *K* is the milling cutter, the teeth of which are arranged in manner analogous to the teeth of a die for tapping nuts. Both *I* and *K*, have a very small pitch and their diameters are large in proportion to their pitch. They are mounted on an arbor *O*, which is supported by the lathe centers and driven in the usual way, *I* acts through the toothed sector and link *H* to feed the blank *L* to the cutter. I should hesitate to say here, how rapidly and cheaply I can cut a thousand of these racks with this device; the figure is so low that it would hardly be credited unless the operation is itself first witnessed. As each rack is completed, a new one is substituted, and by means of a rope running over a pulley and attached to an eye in the middle of the link, the front part of both *D* and *E* are lifted and swung back to their initial position.

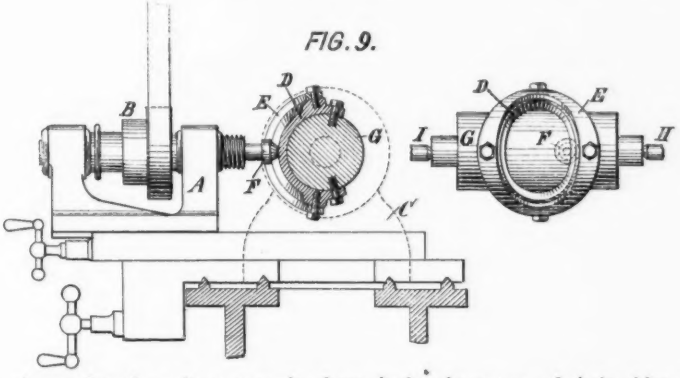
FIG. 8.



In milling male and female dies for rolls intended for use in rolling out tin and brass trays, I arranged to do the work—thought by many good mechanics to be impossible—as follows: On the carriage of an ordinary lathe, Figure 9, the head stock *A* was mounted, and the cone pulley operated by a belt from a countershaft. The live and dead centers of the lathe supported the roll *G*, upon which the dies were to be mounted in use. To this roll was bolted the piece *D*, to be milled. To this again was bolted a ring-gage *E*. On the headstock spindle was mounted the milling cutter provided with the collar *F*. This collar, bearing against the ring-gage when milling, the cutting was limited to points within the ring-gage, all parts of which being cut away, the die attained the correct shape. The figure shows a female die, but the male die is milled in an entirely similar manner.

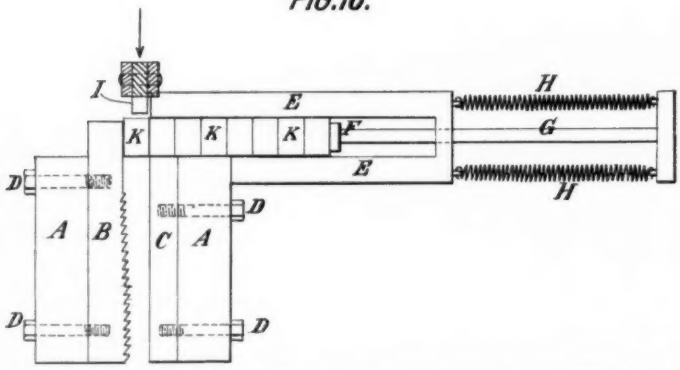
In constructing a considerable number of small machines, many

FIG. 9.



pieces of steel cut in rectangular form, had to have two of their sides made parallel, and the pieces were to be brought with exactness to a standard thickness. One side was made true by lapping. How to get the opposite parallel and bring the pieces to the required width rapidly and cheaply was answered by the device shown in Figure 10. Any shaper will do for this work. To the bed is fitted a metal piece *A*, planed out midwise to receive the hard steel guide *C* and the fixed cutter *B*, leaving a flat-bottomed space between *B* and *C*. Extending laterally is a channel *F*, in which the pieces *K* to be shaved off are placed. *F* is a follower, having the stem *G*, and actuated by the springs *H*. *I* represents a pusher fastened in the tool-holder of the shaper, and which is made to traverse through the space between *B* and *C*, pushing before it one of a series of the pieces *K* which are placed in the channel *E* with their lapped sides toward the follower. In pass-

FIG. 10.



ing through the space between *B* and *C* the pieces *K* are shaved down to exact widths, and one can be finished and thrown out at each traverse of the pusher *I*. The edges of the cutter teeth are inclined slightly from the perpendicular, so that the tendency of the piece operated upon is downward toward the bottom of the space. For about one-third the distance from the exit end, the line of edges of the teeth is parallel to the guide *C*, and by means of the adjusting screw *D*, the width of the finished pieces can be gaged with great nicety.

I have thus presented a few of the resources for economies in special work that from time to time in the progress of a varied business during many years have enabled me to force a profit out of what at first seemed rather unpromising jobs; and I have done this with a view to help others. I do not believe much in "shop or trade secrets" as they are called. The attempt to hide from others what has proved successful, has often stimulated the invention of a more successful thing than the one concealed, ultimately making competition more unequal than the secret method did, and giving advantage to the side on which it was least desired by the concealer. I believe that when useful methods are known, their promulgator confers a public benefit, for which other and higher than pecuniary rewards will follow, and in this spirit I am always willing to respond to any one who makes inquiries, knowing that in the end I shall receive more than I can possibly impart.

THE OUTLOOK FOR SILVER MINING.

By Albert Williams, Jr.

DURING the turmoil of the monetary agitation of 1893 it was well-nigh impossible to persuade either party in that bitter controversy to look at the matter without strong bias, for there were direct personal interests at stake, and every thinking citizen in the United States had very pronounced views on one side or the other. Now that, for the immediate present at least, the financial status of silver seems to be settled, the rancor has given place to a more judicial tone of thought, and we are in a position to discuss the outlook for the industry of silver mining with some show of calmness.

The protracted discussion has made all more or less familiar with the history of silver—how in ancient times it was more nearly on a par with gold, standing at 3:1 in some countries; how in the middle ages it fluctuated within rather narrow ranges down to the time of the Spanish conquests of Mexico and Peru, when it stood at about 14:1; how during the first half of this century it hovered about 15½:1. The first serious decline came about in 1874 when the effect of the new monometallic policy of Germany, and the United States coining law of 1873, began to be felt. From that time on the downward progress was continuous and rapid, until in 1893 the average ratio was 26.49:1, and this year will show an even less favorable ratio. At the extreme depression it exceeded 30:1.

When the decline began in 1873–74 the great bonanza of the Comstock lode in Nevada had just been discovered, and a little later some remarkably exaggerated notions as to its importance began to spread; in fact there was one estimate of two billion dollars' worth of ore in sight! The prospect of a large output in some other silver-mining districts of the United States added to the alarm. Subsequently came the discoveries at Leadville and in other parts of the Rocky mountain region; followed still more recently by the opening of the great Broken Hill district in Australia and the reopening or working on a larger scale, with modern facilities, of various mines in Bolivia, Peru, and Mexico. It was inevitable that the continuous succession of new finds and the steadily increasing production should have had an effect upon the market prices of the metal. This effect indeed has, until quite lately, been cumulative. On the one hand was an augmented output; on the other a repudiation of silver for coinage by several countries which had previously pursued a bimetallic policy.

The two most important recent events affecting the price of silver

were the closing of the Indian mints in June, 1893, and the annulment of the United States silver-purchase act of 1890, which was brought about November 1, 1893. These two changes took out of the market the two largest buyers of silver. The highest quotation in that year was $0.847 per troy ounce in January, and at the end of December it touched $0.664 per ounce. This year the price has been fairly steady, averaging a little above 60 cents, though it dropped temporarily below the 60-cent mark.

The course of prices suffices to explain the present depressed state of the industry. Few products can stand a drop of 50 per cent. in so short a time. True, almost all commodities except gold and some trifling exceptions have been falling; but the decline in silver was an extreme case.

The world's production, as already stated, has been rapidly increasing, but is now being checked. For the latter half of 1893 there was a marked falling off; and while no statistics for the current year are yet available, it is believed that there will be a considerable decrease in the output.

It is not necessary to go back for statistics further than the year 1873—the critical period in the history of silver—for down to that year the price had remained for a long time practically stationary, with the exception of small changes caused by difference in exchange, or a greater or less demand from the Orient, at a figure closely corresponding to the ratios of 15½:1 or 16:1 maintained by the silver-using countries. The following table, compiled from the reports of the United States Bureau of the Mint, will show the relation between the total production and the gold ratio as measured by market price:

WORLD'S OUTPUT OF SILVER AND ITS COMMERCIAL RATIO TO GOLD.

	Production: Troy Ounces.	Ratio.		Production: Troy Ounces.	Ratio.
1873	63,267,000	15.92	1884	81,597,000	18.57
1874	55,300,000	16.17	1885	91,652,000	19.41
1875	62,262,000	16.59	1886	93,276,000	20.78
1876	67,753,000	17.88	1887	96,124,000	21.13
1877	62,648,000	17.22	1888	108,827,000	21.99
1878	73,476,000	17.94	1889	120,214,000	22.10
1879	24,250,000	18.40	1890	126,095,000	19.76
1880	74,791,000	18.05	1891	137,171,000	20.92
1881	78,890,000	18.16	1892	152,940,000	23.72
1882	86,470,000	18.19	1893	161,163,000	26.49
1883	89,177,000	18.64			

That is, in twenty years the annual output had more than doubled while the price had about halved. If silver were a commodity like wheat, or petroleum, consumed in whole from year to year, so that the consumption keeps pace with the production, these changes could be explained simply in accordance with the law of supply and demand—and

would form a very apt illustration of the working of that law. It must not be forgotten, however, that besides the annual increment there is an immense accumulated stock, the result of mining for an indefinite period. What that stock amounts to cannot be stated with any close approach to accuracy, although statisticians have given much attention to the matter on account of its bearing on coinage questions. One guess is three billion ounces; but that may be very far astray, the main uncertainty being as to the amount absorbed and still existing in India, China and Asia generally. So here some modification of theory is necessary. If the estimate of three billion ounces is anywhere near the truth the annual increase during late years has been about one-twentieth of the amount of silver already held. The reduced demand for coinage purposes must therefore be held responsible for a large part of the decline—for a money metal has a somewhat different footing from other commodities in having what might be called an arbitrary demand for coinage in addition to its normal demand for consumption in other ways, the former being affected by legislation to a greater degree than the latter. Only forty years ago there was alarm lest the gold mines of California and Australia by their heavy output might not disturb the relative values of the two precious metals in the opposite direction from what has happened of late.

At present, unless all signs fail, silver is about at the bottom. It is hard to imagine what could happen to it to make its position worse, for the silver monometallic countries are in no condition to go upon a gold basis, if they desired to, nor can countries using large amounts of silver coin, in addition to gold, like France, afford to make a change. The customs of the various silver-using-nations have an influence. The money they are used to they will adhere to, unless under strong pressure to the contrary.

Assuming silver to have really settled down to bottom figures, there is the melancholy consolation of knowing the worst and having nothing further to fear. But is there no light in the future? What can be done? This is a problem of deep moment to silver miners and investors who are already interested in silver mines. The solution lies in three directions:

1. A larger demand for coinage, which is not likely to occur in the immediate future, unless the present sentiment of the world undergoes a very decided change.

2. An increased consumption in the arts, for plate and other tableware, ornaments, miscellaneous small articles for which it is adapted, etc. These are the principal outlets at present. The plating of pistols and similar articles, has been pretty thoroughly occupied by nickel, which though less pleasing to the eye has the advantage of not tarnish-

ing when exposed to sulphurous fumes. There has never been any effort on the part of producers to extend this industrial consumption, though the silversmiths are of course constantly doing so on their own account. It does not seem probable that any new line of consumption in the arts will be opened. The demand will doubtless always be mainly for the manufacture of the same goods now in favor; and the amount of this demand depends upon whether people are prosperous or otherwise. As a country grows rich it tends to luxurious ideas, and with the return of better times there will probably be a greater demand for silver in the arts. On the other hand silver forms the jewelry of the poor, and an astonishing quantity has gone to form bracelets, anklets, etc., in India and China. At present the director of the mint estimates the world's annual consumption of silver in the arts at about 663,000 kilograms of the commercial value (of $0.78 per ounce in 1893) of $16,622,980, or about one-fifth the average annual production during recent years. This is an improvement over the industrial consumption in the time of Humboldt, who estimated that about one fifth the output of both gold and silver were thus disposed of, not separating the two, and probably estimating the greater portion as gold.

3. Another way in which silver mining might be placed on a more satisfactory footing is by reducing expenses. This is not very hopeful, but something might be done. There are but a handful of profitable silver mines compared with those in operation a few years ago. If the price of the metal is to remain stationary an effort to cut down costs still further must be made.

In discussing silver mines a common misconception must be corrected. Silver is so closely related in mode of occurrence to gold and lead and less frequently to copper, and even to antimony, zinc, and iron, that there are a great variety of "silver mines," some of which yield a third or more of their values in gold, some having lead in such quantity as to furnish acceptable ores to the smelters, who are always eager to buy good fluxing ores. The gradations are endless. Now in many instances the silver itself may be regarded as a welcome by-product rather than the main reliance, and during the hard times some of the mines have been enabled to live on in this manner. Altogether there are more mines producing, besides the silver, appreciable quantities of gold, or some other valuable mineral, than there are of straight silver mines. The latter have to be very rich to pay at present prices.

What it costs to produce an ounce of silver is a vexed question. If all the failures and hopeless undertakings, all the abandoned mines, are to be taken into account, the average cost must be very high. It is believed to be considerably over $1 an ounce. But the data are too

deficient to allow of anything like reliable estimates. For single mines, and for some groups of mines or districts, figures are available, and they are not encouraging. Several mines which have paid dividends not long ago would have to suspend if silver dropped a very few cents. Mines that are operated at a constant loss either hold out some hope of a bonanza or the owners feel obliged to keep the pumps going to prevent flooding and the consequent ruin of the workings.

Machinery and supplies are cheaper and better year by year. These items can hardly be reduced in cost much more, in the near future, as competition has brought prices low already. Freight rates have also been cut down nearly as far as they can go, since the railroads in mining regions have to favor the mines, their main reliance. Wages will have to go lower. This item is the last one to be pared down ; but there seems no help for it. Every time an attempt has been made to reduce wages or increase hours the men have made a stubborn resistance, in some cases resorting to violence and destruction of property. They have one advantage over the mine owners ; they can turn to other pursuits, while the investors are often helplessly tied to their properties. Yet for the time being the men have difficulty in making a living when thrown out of employment in the silver mines that close. The general depression in the United States has been doubly severe in the silver-mining states. A process of readjustment has been going on, and those who could have turned to gold mining.

Metallurgical treatment has been slowly cheapening for years, but has now reached a point where there is not much margin for further reduction. Under the most favorable conditions it costs say $4 a ton for treatment of silver ores, whether by mill, smelter or leaching works. Any saving that can be made here will not be large. Still there will undoubtedly be small reductions in each of the items of expense mentioned in the line of changes that have been going on hitherto. However slight individually, these reductions count considerably in the aggregate. In another direction economy must be adopted—in the expenses at main offices of the companies, for rents, salaries, etc., which are almost always out of proportion to the importance of the mines.

But there is a point to which too little attention has been given ; the dressing of ore at the mines, by close hand-sorting and concentration. If the ore is of a character admitting of concentration, a mill for that purpose is very desirable for preparing ore for shipment to custom works. By bringing 5 or 10 tons into one, freight charges and cost of final treatment are reduced to one-fifth or one-tenth, the cost of mining and concentration being based on the gross tonnage. There is of course a loss in concentrating, sometimes heavy. But even if so, it may still be the best policy to concentrate before shipping, in many more cases

w done. The miner must remember that the ore has to be regarded as only one item in his business and put on a level with timber, fuel, explosives, etc., as a raw material like his supplies; indeed as one miner has said, "the ore is the cheapest thing we've got." In this light a loss in concentration appears allowable, if the final net result is bettered.

Exaggerated notions as to the value of silver mines and the facility of mining prevail among the outside public. Bonanzas are rare; borascas frequent. In the management of a silver mine nowadays constant watchfulness to find and stop every little leak is necessary, to say nothing of technical skill. This holds as to the richest as well as to the poorest mines

While the depression has closed so many mines, in individual instances it has had the paradoxical effect of stimulating activity, to the end that the falling off in profits per unit may be partially compensated by larger gross earnings. On the whole the silver output of the United States and of most other silver-mining countries must show a decline for the current year as compared with former records. In this manner the check in the total production may be expected to have a good effect in stiffening prices, in accordance with the usual relation between supply and demand. That is, while the industry as a whole may continue to suffer, those producers who are able to continue operations may secure better prices for their output. In other words silver mining will in a greater measure become automatically regulating, precisely as nearly all other industries have been forced to become. This is not an unhealthy state of things. It is not by any means all that the silver miners would desire, but it is something. In former times the idea that there was any direct competition in silver mining did not obtain. Now it must be recognized. Indirectly, apart from the actual amount of bullion produced, a further beneficial effect will be to remove the impression that there is no limit to the quantity of silver that can be mined, that indefinite stores of it lie available in the ground waiting for some one to dig it up and dump it on the market.

A large advance in price however can hardly be expected for some time to come. Conditions would have to change largely to admit of that. Meanwhile miners will have to do some very close figuring to make both ends meet. This indeed they have long been doing, but the economizing will have to be sharper yet. It is fated that every industry has go through this hard experience. Gold mining is by no means exempt; and possibly, taken generally, it has been conducted more economically than silver mining, for on the whole it has not offered the same chances for unexpected finds as silver mining, the ore bodies being as a rule more regular in size and uniform in grade.

THE STREET RAILWAYS OF ST. LOUIS.

By William H. Bryan, M. E.

NO American city has had a wider or more interesting experience with the various forms of street railway construction and operation than St. Louis. Even in the early days of horse car lines she was progressive and liberal. As the traffic assumed more extensive proportions cable lines were extensively introduced, and she now takes front rank with the greatest amount and most improved forms of electric railways. This inland municipality has long called itself "The Electrical City" of America, basing its claims to the title not only upon its extensive arc and incandescent lighting plants—among the largest in the world—but principally upon the enormous extent to which electricity is employed in its street railway traffic.

This preëminence of St. Louis is in large measure due to the far-sighted and liberal policy pursued by the municipal authorities in dealing with street railway companies. In this they have been supported by an intelligent and progressive public sentiment, which has insisted upon improved rapid transit, limited, of course, by reasonable restrictions as to routes, character of construction, speed, rates of fare, etc. St. Louis has been so fortunate as to escape the effects of the bugaboo of "the deadly trolley" in the hands of the sensational press. It has been shown beyond question that the electric car is one of the safest modes of travel, and is under absolute control. There have been accidents, it is true—some of them serious—but these necessarily accompany any improved system in the narrow and crowded streets of a great city. Since the days of George Stephenson rapid transit has necessitated not only increased skill and care upon the part of the operators, but greater caution on the part of all who use the public streets and highways. Although the people of St. Louis early recognized these facts, they preferred to accept the conditions imposed rather than remain indefinitely in primitive indifference, awaiting the development of an ideal system which should be absolutely dangerless.

St. Louis has neither the monotonous flatness of Chicago, nor the abrupt and often mountainous grades of Kansas City and San Francisco. Its traffic is not limited to a single line, as is that of the city of New York, but spreads in all directions from the business center to the west of a north and south line, the Mississippi river limiting the traffic eastward. The manufactories and railroads occupy almost the whole of the fourteen miles of river front, while the parks and resi-

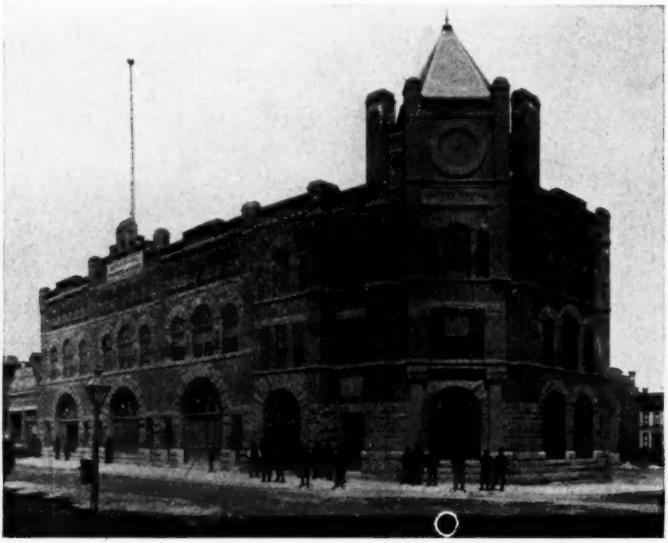
FOREST PARK STATION, LINDELL RAILWAY.

[Showing Regular Trains Consisting of Motor Car and Trailer.]

FOREST PARK STATION, DELMAR AVENUE DIVISION OF LINDELL RAILWAY.

[Showing Long Double Cars in Use.]

dence districts lie to the west. The fare on all the lines is five cents, except for children. No forms of commutation or rebate tickets of any kind are sold. Recent combinations of different lines under consolidated managements have resulted in the widespread adoption of the transfer system, so that it is now possible to board a car at Calvary cemetery, in the extreme northwestern portion of the city, and ride with but one change of cars to Carondelet—a distance of some thirteen miles—for a single fare. Under such exceptionably favorable conditions it would be natural to suppose that many interesting and valuable



POWER HOUSE AND OFFICES, PEOPLE'S RAILWAY CO.

street railway experiences have been had in St. Louis. It is the purpose of this paper to place some of these on record.

Not the least among them is the increase of travel which has followed the introduction of rapid transit, particularly with roads whose motive power has been changed from horse to electricity. It has not always been easy to account for this improvement. Competing lines suffer to some extent, but their losses do not account for all the gain. There is an increase in the grand total of travel, due no doubt to the adoption of better methods and more attractive surroundings. Rapid transit shortens distances, thus bringing together the residence

and business districts, and building up outlying areas, hitherto inaccessible. It permits the man of modest means to enjoy the comforts of his own roof and his little plot of ground within reach of his office or shop. Who can tell how much has thus been added to the sum total of human happiness?

With more miles of electric road than any city in the world, and with an important showing of the most improved and modern cable line construction, St. Louis may well claim an advanced rank in rapid street railway transit. At this writing (September, 1894), the electric lines are as follows, in miles of single track:

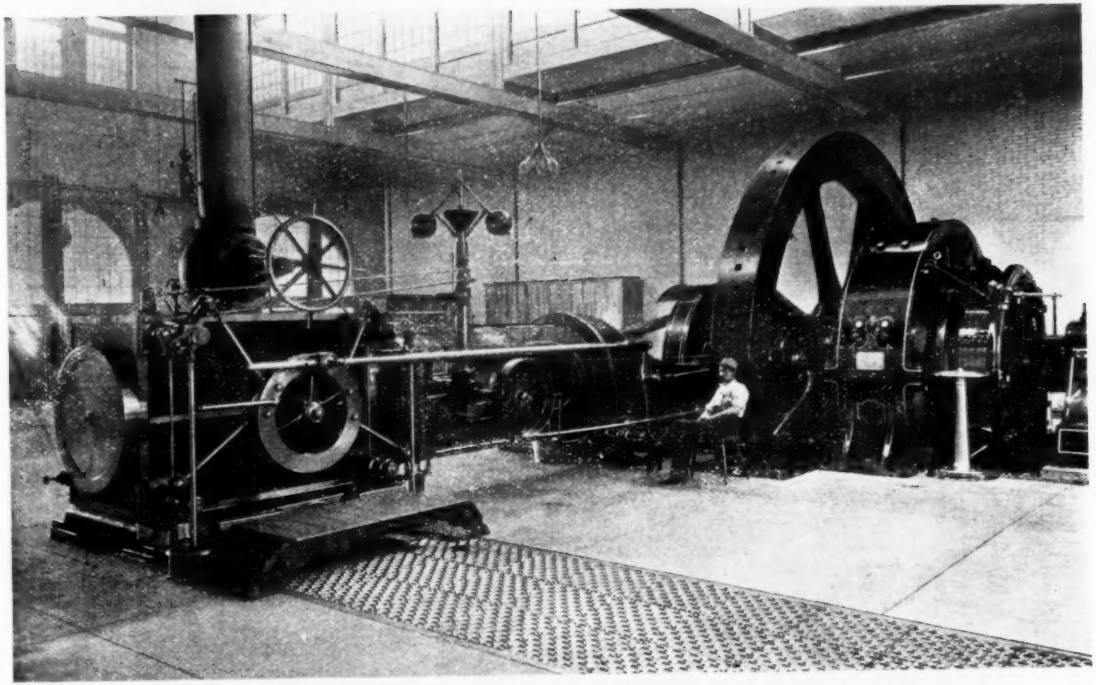
CABLE POWER HOUSE, MISSOURI RAILWAY CO.

Union Depot system, including its Cherokee Division, Tower Grove Park, Carondelet, 18th street, Northwestern, Mound City, and Bellefontaine lines..... 63.80

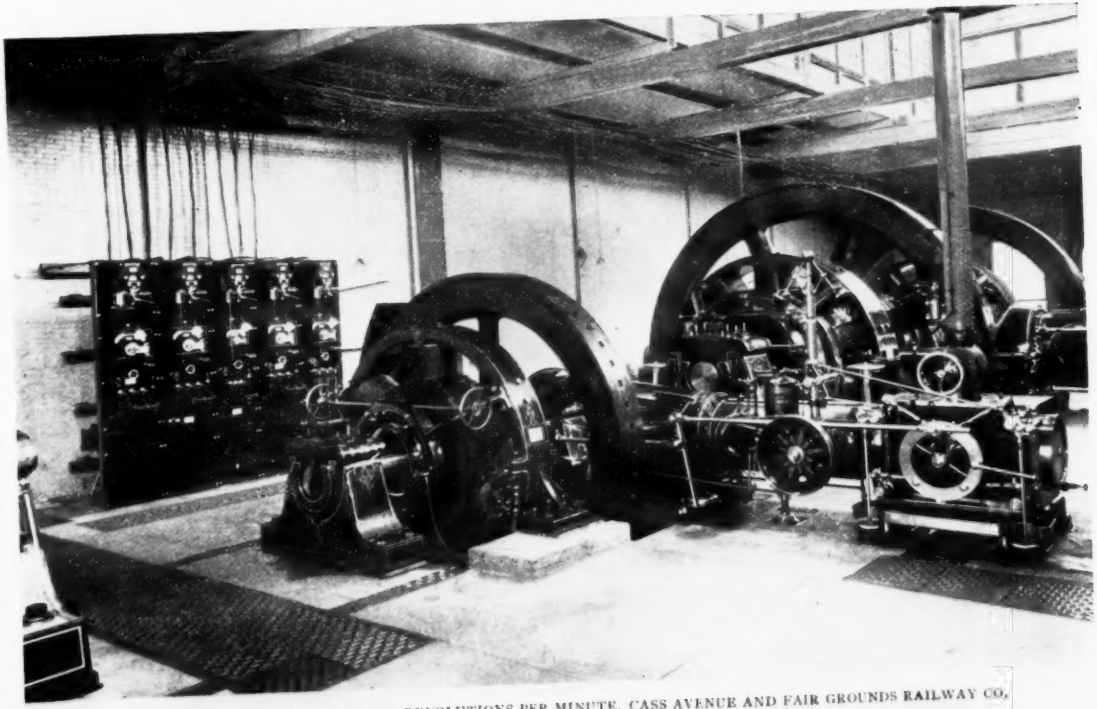
Lindell Railway system, including its Forest Park, Page avenue, Vandeventer avenue, 14th street, Taylor avenue, and Compton Heights lines..... 48.25

Cass avenue system, including Cass avenue and Fair grounds, Northern Central, and Union lines..... 32.37

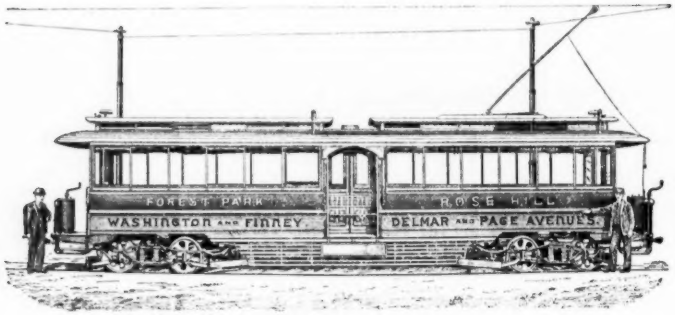
St. Louis and Suburban Railway, including its main double track line, its single track extension into St. Louis county, (10 miles) and its Forest Park loop..... 29.50



1000 H.-P. ALLIS ENGINE AND GENERAL ELECTRIC GENERATOR, CASS AVENUE AND FAIR GROUNDS RAILWAY CO.



SMALL CORLISS ENGINE, SPEED 150 REVOLUTIONS PER MINUTE, CASS AVENUE AND FAIR GROUNDS RAILWAY CO.



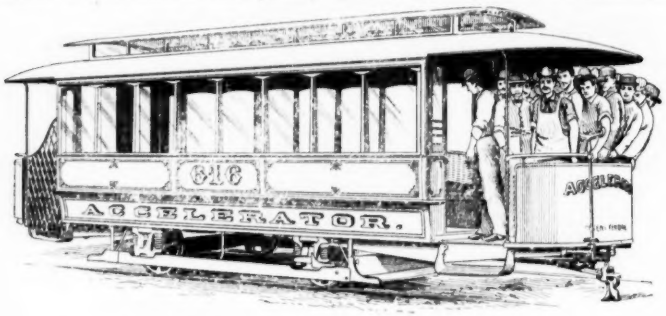
BAUMHOFF'S LONG CAR.

Missouri Railroad Co.	16.70
Southern Electric Railroad	15.67
Baden and St. Louis Railway	6.70
Citizens' Railway—Grand avenue branch	2.37
Total	215.36

The cable lines are the St. Louis Railway Co., 14.67 miles; People's Railroad Co., 10.10 miles; Citizens' Railway Co., 9.78 miles; Missouri Railroad Co., (now being changed to an electric line) 9.06 miles; total, 43.61 miles.

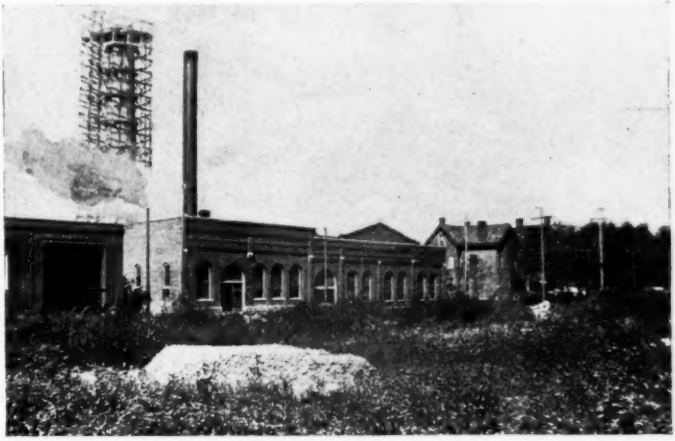
The horse lines are the Jefferson avenue, 5.70; Fourth street and Arsenal, 3.50; Citizens' Railway—Marcus and Easton avenue branches, 3.15; total, 12.35.

The total length of electric, cable, and horse lines, is 271.32 miles single track. Not a bad showing for a city of 600,000 inhabitants. Much of this track is used jointly by different lines. If the distances



THE BROWNELL CAR COMPANY'S "ACCELERATOR."

were computed from the actual trip lengths, the total would be at least fifty miles greater. Legislation has been secured and plans are already practically complete for the change of the remaining horse roads to electricity. The last vestige of prehistoric modes of urban travel will then vanish, and the change from "mule to fuel,"—as it has been aptly termed, will be complete. Nor is new construction at a stand-still. The following electric extensions are now under way and nearing completion: Lindell Railway Co., 11.62 miles; Union Depot Railway Co.,—Grand avenue line, 8.00 miles; Southwestern Railway, 7.40 miles; Citizens' Easton avenue line, 1.66; Southern Elec-

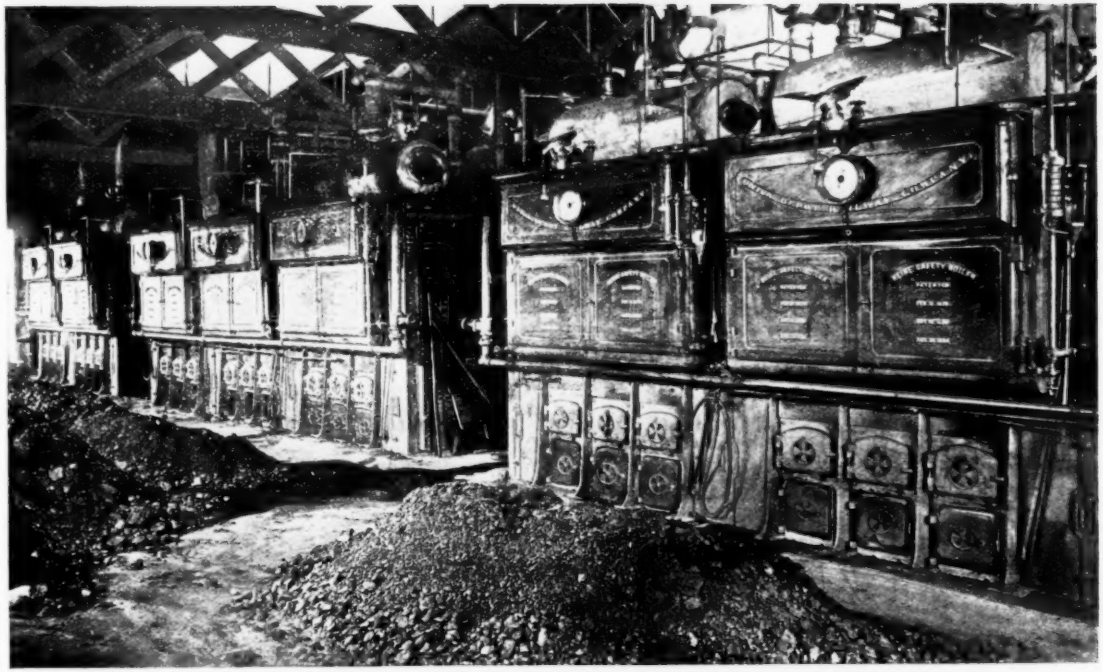


POWER HOUSE, UNION DEPOT RAILWAY CO.

tric Railroad Co.,—up-town extension, .89 miles: total miles single track, 29.57.

The total business for all the roads covering the second quarter of the year 1894, as indicated by returns filed with the city register, was 1,433,421 trips, and 24,773,660 passengers. For the same period of the year 1893, the totals were: trips, 1,625,799; passengers, 26,186,742. This indicates the slight extent to which the traffic was affected by the widespread business depression of the year 1894.

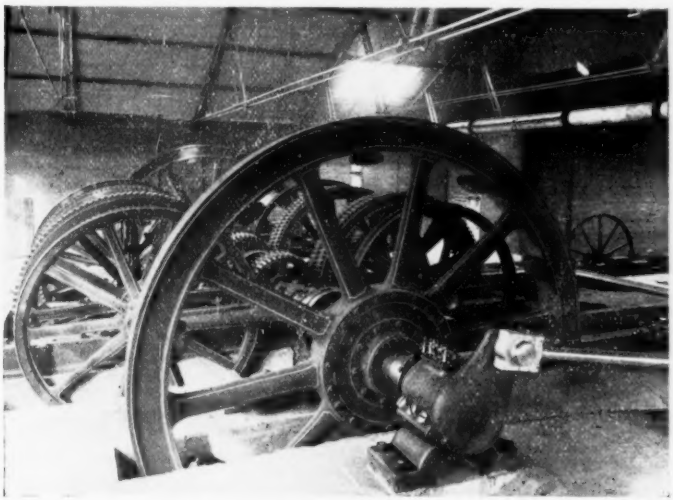
St. Louis has had little or no experience with other forms of motors. Nothing has been done, nor is likely to be done, with steam dummies, gas, ammonia, or compressed air motors. The lines are all on the surface. Franchises have been secured for elevated roads, but their great first cost and the doubt as to their improving to any great extent upon existing methods, has kept them from advancing into



HEINE SAFETY BOILERS. BOILER ROOM OF UNION DEPOT RAILWAY CO.

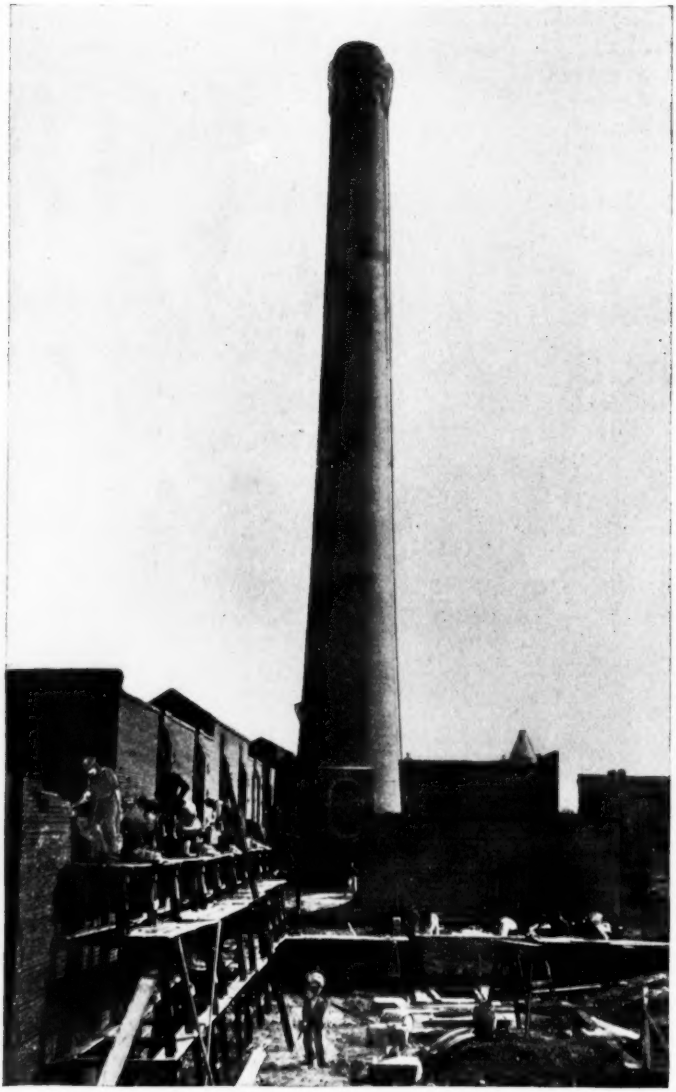
favor either with the public or capitalists. In the early days of the electric railway problem, the Lindell Railway Co. spent about six months in trials of storage batteries, using Brush-Julien cells. These experiments, however, were finally abandoned on account of the weight, excessive depreciation, low efficiency, and high first cost.

Several cable roads which proved unsatisfactory were changed to electric lines, with the result that they became successful at once. The St. Louis and Suburban, built in 1876, was operated originally as a narrow gage steam railway, over its own right of way from Grand avenue and Olive street to Florrissant, in St. Louis county. In 1885



POWER ROOM, ST. LOUIS RAILWAY CO., BROADWAY CABLE LINE.

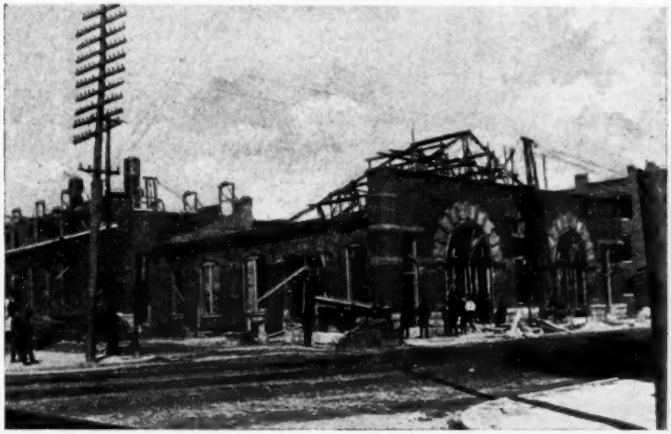
the down town portion, from 6th and Locust streets, was constructed as a cable road. Being the first road of this character in the city it was immediately successful, and compelled prompt action on the part of parallel lines to secure rapid transit. The Suburban company's franchise was granted by an unfriendly council, and its right of-way was a round-about one, with many curves of short radius. Rapid transit on the more direct lines caused a falling off of its traffic, and the excessive operating expenses, due to the power required and the wearing out of cables, soon bankrupted the road. A reorganization being effected it was decided to reconstruct the entire line and equip it with electricity as the motive power.



CHIMNEY, UNION DEPOT RAILWAY CO.

This line was the first street railway in this country to be used regularly as a United States mail route. The service has been in very satisfactory operation for a period of more than two years. There is a full equipment of regularly furnished and specially fitted mail cars, which go over the entire route twice a day. These cars run on a regular schedule, and are due at definite times at certain corners, where mail is delivered to carriers for distribution over their respective routes. So successful is this service that it has been adopted in other large cities.

The Suburban is not the only road, however, which has found it wise to change from cable to electricity. The Grand avenue branch of the Citizens has undergone a similar transformation with the most



POWER HOUSE, ST. LOUIS RAILWAY CO., BROADWAY CABLE LINE.

gratifying results, and the main line of the same company is now being reconstructed.

It has been possible in St. Louis to make comparisons as to the relative cost and operating expenses of cable and electric roads. The most recently built electric road is the Cass avenue system, which embodies the best features of modern electric railway construction. Among ths last cable roads constructed, was the Citizens, which was well built in accordance with the best practice of that day. These lines are operated under the same management, and an excellent system of records is kept by the company's engineer, Mr. Richard McCulloch, E. M. The conditions here are favorable for a fair comparison between the two systems. The number of cars operated, trips made,

MOTOR CAR, UNION DEPOT RAILWAY CO.

passengers carried, character and hours of travel, grades, and speed, are all of the same general character. If anything, the conditions appear more favorable to the cable than to the electric road, on account of the short length of the former, and the few curves. The records for the month of March, 1894, are as follows:

On the Citizens' (cable) line, the average number of trains (two-car) was 35, running each 107 miles daily. The horse-power per train, gross (including cable), was 18.32, and horse-power, net (exclusive of cable), was 6.38. Coal consumed per train mile was 11.18 pounds. Coal consumed per horse-power hour was 5.18 pounds. Water consumption per horse-power was 23.93 pounds. The average total load was 413 horse-power. The average friction load—cable only—was 2.69 horse-power or 65.13 per cent. of the total.

The engines are of the ordinary Corliss pattern, single cylinder, non-condensing. The boilers are of the horizontal return flue type, with 6-inch flues. The coal is the ordinary soft bituminous of southern Illinois, such as is used almost exclusively in St. Louis. It averages in calorific power about 10,500 British thermal units per pound, and 15 per cent. ash.

On the Cass avenue and Fair Grounds Electric Railway the average number of motors was 69, each running daily 125 miles, and 26 trailers, averaging 62 miles. The average horse-power per motor car was 15.52. The coal consumption per motor mile was 7.76 pounds. The coal consumption per train mile was 8.15 pounds. The water consumption per horse-power hour was 25.21 pounds. The coal consumption per horse-power hour was 4.22 pounds.

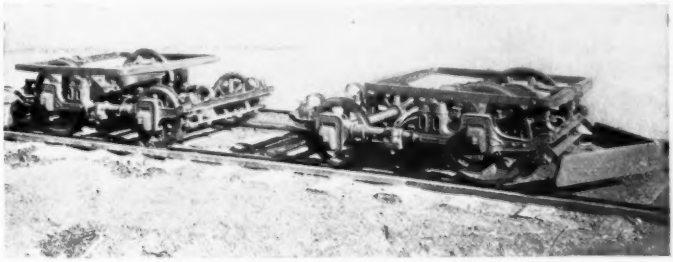
In computing these totals four trailers were assumed to be equiva-

lent to one motor car. The latter are of the large single truck pattern, with 21 feet bodies and 7 feet wheel bases. Each is equipped with two 25 horse-power motors.

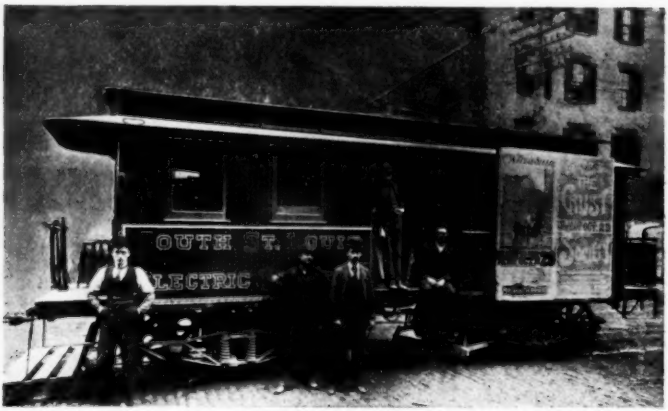
The engines are of the Corliss pattern, single cylinder, non-condensing. Three of them are 34 × 60, speed 92 revolutions, initial steam pressure 85 to 95 pounds, directly connected to 750 kilowatt multipolar generators. There is also an 18 × 36 Corliss running 150 revolutions, directly connected to a 250 kilowatt generator. The boilers are the same as at the Citizens' plant, except that they are set with down-draft smokeless furnaces.

The above figures show that the average horse-power used for each motor car is 15.52, and for each cable train 18.32,—a difference in favor of the former of about 15 per cent. It must not be forgotten, however, that the cable or friction load being constant, additional cable trains would require but 6.38 horse-power each, while additional motors would call for 15.52, considerably more than twice as much. The electric system, however, covers a mileage over three times as great as that of the cable. If the latter served as large a mileage, more length of cable would be required, and the power for the same number of cars would be greatly increased; while if the number of cars were enlarged at the same time, the power per car would be reduced to approximately the same figures given above.

These results, however, are from a single pair of roads. There are cable roads using less power per train, and there are electric roads using more. A considerable proportion of the saving in fuel is undoubtedly due to the better steam plant of the Cass avenue system, which requires but 4.22 lbs. of coal per horse-power hour, while that of the cable line consumes 5.18. Furthermore, the Cass avenue system is new in every part, while the Citizens' line has seen five years of very severe service, and as a result its operating and maintenance expenses have increased.



THE AMERICAN CAR CO.'S DOUBLE TRUCK.



SOUTH ST. LOUIS ELECTRIC EXPRESS CAR.

These figures point clearly to the conclusion that where a traffic exists sufficiently large to justify numerous trailers and close spacing, on a comparatively limited length of line, the cable is to be preferred. On the other hand, where the amount of track is extensive, and where the traffic per mile is less, electricity clearly has the advantage.

This, however, is not the whole story. Sometimes local conditions determine absolutely whether cable or electricity is the better. No electric road, whatever its traffic or extent of line, could operate successfully on such steep grades as are handled satisfactorily by the cable in San Francisco and Kansas City. On the other hand, such curves as are frequently necessary in St. Louis and Boston would prove disastrous to any cable line.

There are two troubles which seriously hamper the cable road. One of these, the closing of the slot in cold weather, has caused some of the St. Louis roads untold annoyance and expense. The other is the wearing out of the cable, and the expense attending its renewal. Now that the repairs to armatures have been reduced to only nominal cost, there are no corresponding outlays in electric railway work.

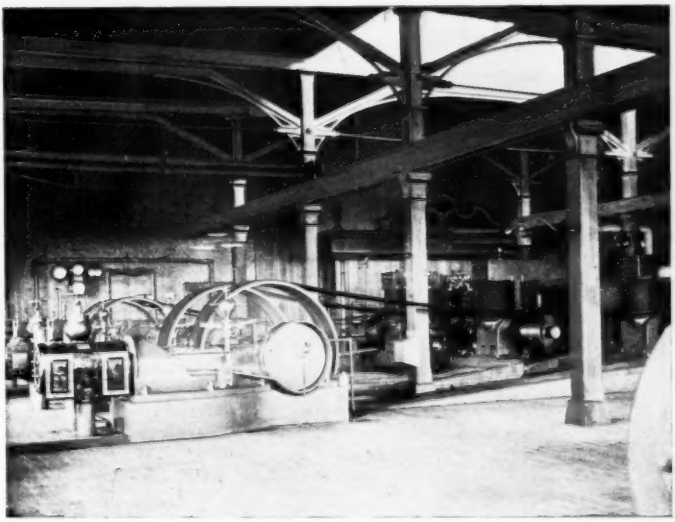
It would be difficult, if not impossible, to make up accurate tables showing the relative first cost, and the cost of operation of cable and electric roads; and when made, they would apply only to the particular roads to which they refer. In general it may be said that for roads operating more than twenty cars, the first cost of the electric plant complete is in the neighborhood of two-thirds of that of the cable, presuming the construction to be equally good in each case.

The experience of St. Louis roads indicates that the operating expenses are nearly the same, estimated at about 65 per cent. of the gross receipts. A new electric road has some advantages over an old cable road, while a cable line in good repair and with few curves, might show better results than an older electric line.

It is clear, therefore, that while certain general principles may be stated, no positive opinion can be given regarding a particular road, nor can a definite recommendation be made, except after a thorough study by a competent engineer of the local conditions affecting that special case.

A specially interesting feature of the Cass avenue plant is the high piston speed of the large Corliss engines—920 feet per minute; and the high rotative speed of the small engine—150 revolutions per minute, or 900 feet piston speed. Until very recently these rates have been considered inconsistent with reliability and durability, but these engines have now been in service for more than a year, and are doing excellently well.

The Southern Electric Railroad runs from near the Court House to the river Des Peres, in the extreme southern part of the city, eight miles distant, formerly the old town of Carondelet, but now within the city limits. The admirable service rendered has led to the

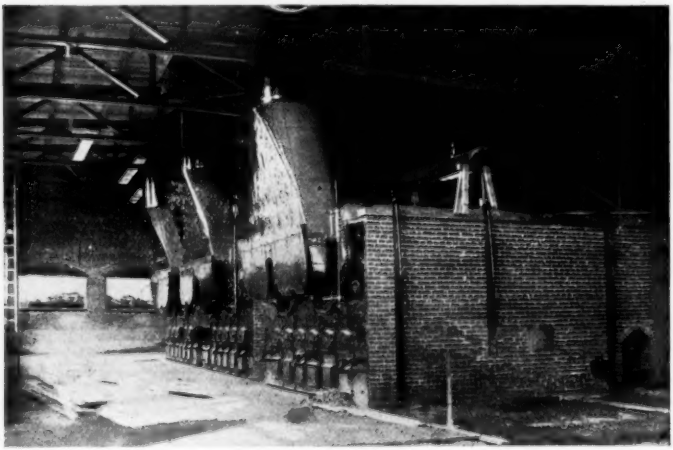


ENGINE ROOM, LINDELL RAILWAY CO.

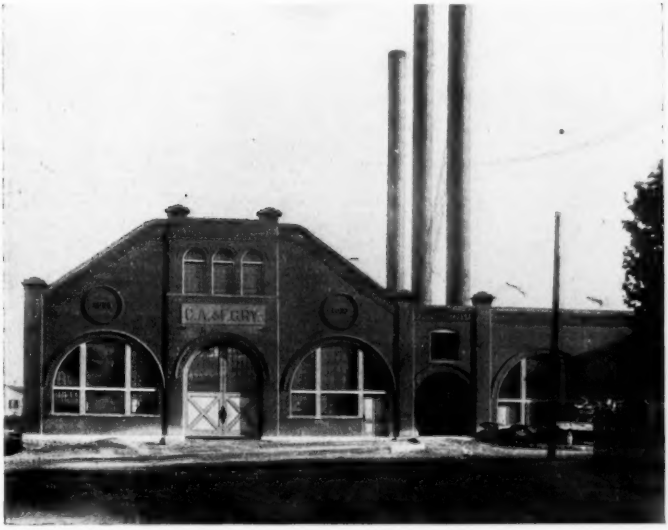
almost total discontinuance of the steam railway service, which was formerly the only means of communication. In addition, the Southern Company operates an express service, by means of specially arranged cars which make regular trips over the entire line at stated intervals. The company's delivery wagons bring goods to and deliver them from the uptown terminus. There are also two stations along the line at which delivery wagons take goods from the express cars and deliver them throughout the territory adjacent. This service has proved profitable to the company and satisfactory to its patrons. No line in the city has attempted any freight business.

A novel and interesting feature has just been added on the lines of the Union Depot system. The city health department has built an electric ambulance, which forms the principal communication between the city dispensary at the city hall and the various hospitals. The ambulance is specially fitted for the purpose, and is a model of convenience and elegance. Should this service continue to meet expectations it will be applied to other lines.

Electrolysis has caused the electric railways of St. Louis considerable trouble and expense. The system of distribution employed is the overhead trolley, with ground and rail return. The rails are well bonded, and in many cases supplemental return wires have been laid and ground plates buried in permanently moist earth at frequent intervals. These have always been deemed sufficient, the resistance of the earth return having been supposed to be negligible. The fallacy of this belief has,



BOILER HOUSE, ST. LOUIS AND SUBURBAN RAILWAY CO.



POWER HOUSE, CASS AVENUE AND FAIR GROUNDS RAILWAY CO.

however, been repeatedly demonstrated of late. The return current, dividing itself among the different channels available, in the inverse ratio of their respective resistances, finds ready paths in the water and gas mains. This of itself would not be particularly objectionable if it were possible to control and confine the current within these lines. Near the power plant, however, the current must leave these channels and return to the generators, and it is here that electrolytic action is the most manifest. In many cases the losses due to the eating away of the pipes have been disastrous and costly. The evil has been reduced to some extent by connecting the rails to the gas and water mains at frequent intervals, and running specially heavy conductors from them to the generators at the station. A further remedy lies in the addition of return circuits connected frequently with the rails. In several cases it has been recommended that as much, or even more, copper be provided for the return as for the feeders, but this can only be a partial remedy. As long as a number of paths are available, each will carry such portion of the current as its relative conductivity determines. While we continue to use the ground for the return, gas and water mains will carry some proportion of the current, and some degree of electrolytic action will follow. The only complete remedy is to do away with the ground return—a prospect by no means inviting.

MOTOR CAR, ST. LOUIS AND SUBURBAN RAILWAY CO.

This brings up the question of welded rails, which usually have a cross section of far greater carrying capacity than the overhead feeders. This will largely reduce the electrolysis, and while it will not wholly stop it, it will usually bring it within such small limits as to be no longer serious.

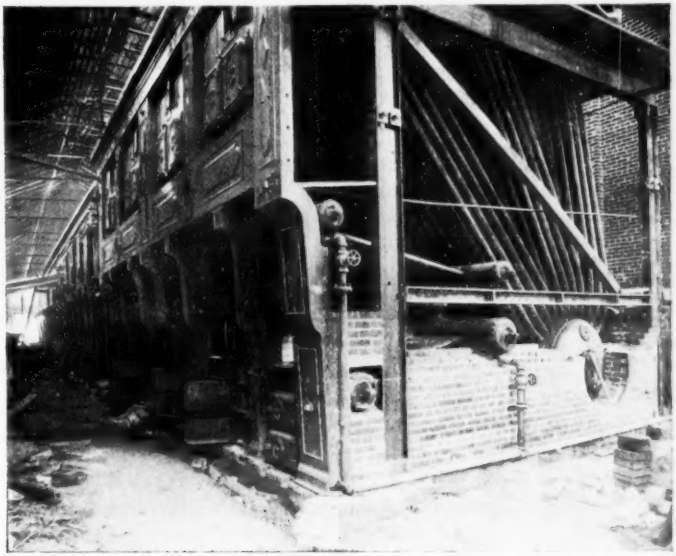
The Baden extension of the St. Louis Railway Co. has just been completed with all the joints welded according to the standards recently adopted by the Johnson Co., of Johnstown, Pa. The line consists of two tracks each 3.35 miles long. Thus far no troubles have developed, and it is not believed that the expansion and contraction will cause serious difficulties. Only a small number of joints have thus far broken, less than one per cent. In every instance the break was traced to a defective weld, due no doubt to the inexperience of the operators handling the apparatus. It will be interesting to observe the condition of this track after it has passed through the winter.

Most of the large cable and electric plants are situated well out in the residence districts, and the smoke from their chimneys, resulting from the use of our soft bituminous coals, became quite a nuisance at one time. The city has recently passed a stringent smoke abatement ordinance, which is being rigidly enforced. This has resulted in the development of numerous improved types of boiler setting, and at present none of these chimneys are serious offenders. Some of them present an almost absolutely clean appearance at all times.

Lying within eight miles of St. Louis on the east is the western edge of the extensive coal fields of southern Illinois, from which a large part of the fuel supply of the Mississippi valley is drawn. At each of these mines there is a considerable proportion of slack or coal dust,

which it usually does not pay to market. If sold at all, it is at the bare cost of handling, and sometimes at even less in order to get it out of the way. There is no reason why the large street railway power plants of this city should not be removed to these coal lands. The wonderful developments recently made in multiphase apparatus brings this plan clearly within the range of commercial possibility. The fuel cost would be almost entirely wiped out, and the loss in transmission can (by the use of step-up and -down transformers) be kept within quite reasonable limits, without excessive investment in copper. The plan is quite as practicable as that at Niagara, and the conditions are much more favorable. Not only would this part of the smoke nuisance be effectually obliterated, but the economical results, due to reduced fuel cost, concentration of machinery under a single management, improved arrangement, ample ground space, air, and light, with reduced cost of labor, taxes, and insurance, are all of the greatest importance.

Possibly when the consolidation of all the street railways of St. Louis is effected—a scheme which is even now being worked out—we may hope to see some progress in the direction of utilizing these immense sources of power now going to waste.



STIRLING BOILERS WITH DOWN DRAFT FURNACE IN NEW POWER HOUSE OF LINDELL RAILWAY.

GENERATING ELECTRICITY BY WINDMILLS.

By Lieutenant I. N. Lewis.

"Windmills lend revolving animation to the scene."—*Hood.*

THE problem of controlling and utilizing the so-called waste forces of nature has never occupied the prominent position before the industrial world that it does to-day, nor has it ever received such intelligent consideration and study.

The wholesale destruction of our forests, the failure of many of our gas and oil wells, and the great annual increase in our already enormous coal consumption, warn us that the fuel supply of the world is being rapidly exhausted.

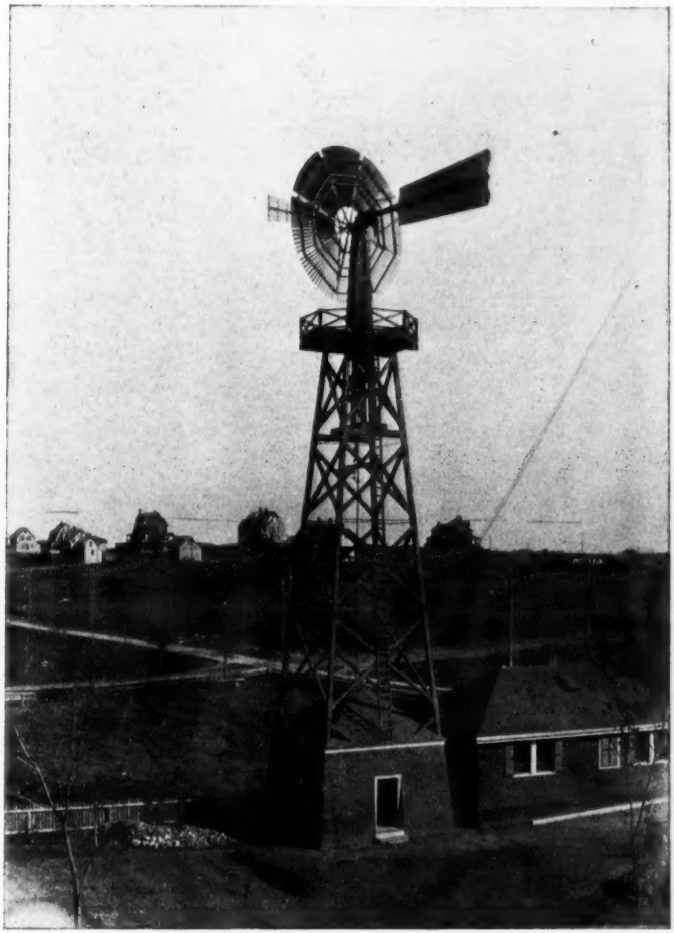
The steam-engine is so closely associated with every element in our nineteenth century civilization that it may almost be credited with having made this civilization possible. Recognizing this, we are slow to consider what an extravagant worker the steam-engine really is, and how absurdly large is the amount of fuel consumed, in proportion to the useful work done. The waste has been going on for so many years that we accept its necessity as a matter of course. Yet each pound of fuel thus consumed is one pound taken from that great store of potential energy which past ages have so bountifully provided for the comfort and well-being of the present one—a store which once exhausted, can never be replenished.

Perhaps the genius of a Tesla guided by the researches of modern electro-chemistry, may yet discover some practical, economical way to change the potentiality of coal directly into electricity, without the useless heat wastes involved in present methods. If so, there will be a postponement of the inevitable.

But in the meantime, how is the ever increasing demand for *cheap power* to be met?

I believe a partial answer to this query is to be found in that magnificent power-plant now nearing completion at Niagara.

Up to the time of the introduction of steam, the two great natural forces of wind and water were the only ones available to man for power purposes. Both the windmill and the water motor were, therefore, used to a considerable extent for such heavy work as could not well be done by hand. The crude processes and tools of the day, combined with a general ignorance of the laws of mechanics, prevented their development, and it is only within a very recent period that either of these motors has been brought to a perfection of mechanical detail sufficient to entitle it to be considered a commercially efficient machine.



ELECTRICITY FROM WIND POWER—LEWIS SYSTEM.

[Windmill at Marblehead Neck, Mass.]

The water motor has been accorded its proper place in the list of prime movers; why should the windmill be so generally ignored?

It is true, the wind is the most inconstant, the most erratic, of nature's forces; in many respects it is the least to be depended upon, and

ELECTRICITY FROM WIND POWER—LEWIS SYSTEM.

[Summer residence of Mr Geo. E. McQuesten and Col. Elbert Wheeler, Marblehead Neck, Mass.]

the most difficult to control; but, granting this, it constitutes such a vast natural reservoir of power that its real importance in this respect must soon be recognized by the engineering profession.

A history of the windmill itself, however briefly sketched, would be out of place in this paper, since I must confine myself more particularly to a single one of its many useful applications; but it will no doubt be of interest to the reader, and will give him some idea of the present magnitude of this industry, to learn that there are more than one million windmills in actual operation in the United States alone. Twenty different firms are engaged in the manufacture, and their combined sales exceed one hundred thousand mills each year.

The use of windmills for generating electricity, was first suggested by Sir William Thompson in 1881.

In his presidential address "On the sources of energy in nature available to man for the production of mechanical effect," delivered before Section A of the British Association for the Advancement of Science, in that year, this distinguished English physicist brought this subject before the scientific world in the following significant language:

"When we look at the register of British shipping and see 40,000 vessels, of which about 10,000 are steamers, and 30,000 sailing ships, and when we consider how vast an absolute amount of horse-power is developed by the engines of those steamers, and how considerable a proportion it forms of the whole horse-power taken from coal annually in the whole world, and when we consider the sailing ships of other nations which must be reckoned in the account, and throw in the little item of windmills, we find that even in the present days of steam ascendency, old-fashioned Wind still supplies a large part of the energy used by man. . . . The subterranean coal stores of the world are becoming exhausted, surely and not slowly, and the price of coal is upward bound. When the coal is all burned, or long before it is all burned, when there is so little of it left, and the mines from which that little is to be extracted are so distant, and deep, and hot, that its price to the consumer is greatly higher than at present, it is most probable that windmills, or wind motors in some form, will again be in the ascendant, and wind will do man's work on land at least in proportion comparable to its present doing of work at sea. Even now it is not entirely chimerical to think of wind superseding coal in some places for a very important part of its duty—that of giving light. Indeed, now that we have dynamos and Faure's accumulator, the little want, to let the thing be done, is cheap windmills. . . . The probable cost of dynamo and accumulator does not seem fatal to the plan, if the windmill could be had for something comparable with the prime cost of a steam-engine capable of working at the same horse-power."

Words such as these, coming, as they did, from the most eminent, as well as the most conservative, scientist of the day, naturally attracted wide attention both in Europe and America. The question was taken up in the technical press, and was frequently discussed by electrical and mechanical experts in both countries, but nothing in the way of practical demonstration was attempted for some years.

In fact the time had not then arrived when a practical demonstration could be made with even a fair probability of success. Windmills, thirteen years ago, were costly and inefficient, the dynamo was still largely in the experimental state, badly designed and constructed, while the storage battery was viewed with distrust on account of its failure to realize immediately all that had been predicted of it in the first years of its introduction. The conclusion reached by the majority of those who made a study of the problem, was to the effect that such a system of lighting could never become a commercial success because of the excessive first cost, and the difficulty of adapting the electrical apparatus to such a variable and inconstant source of power.

Some five years later, M. Charles de Goyon, a Frenchman, conceived the idea of using wind motors on a large scale to charge accumulators, and then distributing the current to small land owners and cultivators at a fixed price. His experiments, however, proved expensive and the attempt was soon abandoned.

The next year (1887) an engineer, M. Beaumanoir, was authorized by the minister of public works in France, to establish a windmill and the necessary electrical apparatus, at Cape de la Heve, for the purpose of supplying electric light to one of the large lighthouses on that promontory. This plant deserves more than passing mention, not only because of the success attained, but the rather because it suggests a most important future field of usefulness for windmill electric lighting. M. Beaumanoir selected, as best suited to this work, an American Halladay mill, of the largest size then made. This he mounted upon a heavy tower of oak, with a masonry foundation. The electrical apparatus was placed in a small building at the foot of the tower, the main vertical shaft of the mill being connected by bevel gearing to a horizontal counter-shaft within the building.

Recognizing from the first, that the greatest difficulty to be overcome, would be to operate the dynamo safely at the widely varying speeds to which it would naturally be subjected, M. Beaumanoir hit upon the novel expedient of using alternately, two dynamos of different capacities. The dynamos selected were slow-speed, 75-volt Brush machines of the old Victoria type, each provided with an automatic field rheostat, and an automatic device for shifting the brushes. The smaller machine

was rated at four horse-power, while the larger had a capacity of sixteen horse-power, or, sufficiently great to utilize the maximum power developed by the mill in the strongest wind. As both dynamos were operated from the same counter-shaft, a rather complicated arrangement of clutches and gear wheels was necessary in order that while one dynamo was at work the other would be idle.

In light winds, the smaller dynamo did the work of charging the battery, the current out-put gradually increasing, as the wind increased in force. When this current reached a predetermined maximum of 40 amperes, an automatic switch, operated by the current, threw out the smaller dynamo, and, at the same instant, threw in the larger one. The storage battery consisted of 32 cells, of sufficient capacity, when fully charged, to furnish the necessary light for three consecutive nights.

This plant was in practical operation for some considerable time; but just how long, or with what degree of success, I have not been able to learn.

Within the past three years the question of using wind power to produce electricity has been revived in England, and one or two small experimental plants are said to be in operation there at the present time, but there are no published data at hand concerning them.

In the United States, the history of windmill electric generation would be practically all included in a history of the single elaborate plant erected by Mr. Chas. F. Brush, at his city home, Cleveland, Ohio, in 1887, and which is still in entirely successful operation.

Only a brief general description of Mr. Brush's work in this field will be attempted, but it is certainly no exaggeration to say that his is the most ingeniously designed, the most carefully worked out, and complete,—the most thoroughly unique, private electric plant in America. Every contingency is provided for, and the entire apparatus, from the huge 56-feet wheel of the mill, down to the most delicate electrical device, is automatic throughout.

The windmill tower is a closed, rectangular structure, 60 feet in height, pivoted upon a single wrought iron gudgeon, 14 inches in diameter, which extends some 8 feet below the level of the ground in solid masonry. The whole tower with its contents, consisting of shafting, pulleys, belts, dynamo and fittings, etc.,—the total weight of which exceeds 80,000 pounds,—not only rests upon the gudgeon, but is free to revolve about it as a vertical axis.

In the upper part of the tower is journaled the main wheel shaft of steel, 20 feet long and 6½ inches in diameter, with self-oiling bearings 26 inches in length. This horizontal main shaft carries the main driving pulley, 8 feet in diameter, with a face 32 inches wide. A

counter-shaft arranged just below, and parallel with the main shaft, carries three pulleys; the middle one receiving the main driving belt, while the two end pulleys are belted directly to smaller pulleys, one at each end of the armature shaft of the dynamo. The relative diameters of these different pulleys are such as to make the armature speed of the dynamo 50 times that of the mill wheel. The dynamo does not rest upon a solid support, but by a novel arrangement of counter-weights it is partially suspended by the two driving belts, only so much of its weight being allowed on the belts as is necessary to prevent them from slipping.

The dynamo, one of Mr. Brush's own design, is provided with an automatic switch to throw the machine into effective action when the speed reaches 330 revolutions per minute, and an automatic regulator which prevents the voltage rising above 90 volts at any speed. The working circuit is arranged to close automatically at 75 and open at 70 volts. The brushes of the dynamo rock automatically as the load changes. The field is slightly compounded. The normal electrical out-put at full load is 12 kilowatts, which requires the mill to develop at least 24 horse-power.

The current generated passes to steel contact shoes, which slide upon annular plates surrounding the gudgeon as the tower turns with the changing direction of the wind, and thence by underground conductors to the storage battery in the basement of Mr. Brush's house.

The battery consists of 408 cells of 100 ampere-hours capacity, arranged in 12 groups of 34 cells each. These groups are charged and discharged in parallel. The containing jars are of glass, and the liquid in each is covered with a film of oil, thick enough to prevent evaporation and spraying. The basement room containing the battery is a veritable electrical laboratory. The list of electrical instruments in daily use, besides the usual voltmeters, ammeters, switches, fuse blocks, etc., includes a series of potential indicators, one for each group of cells; an electrically operated switch, by means of which the current may be turned on or off the house mains, by pressing push buttons in different parts of the house; a ground detector for the battery; a leakage detector for the different lamp circuits; and finally, and most ingenious of all, a compound relay which controls automatically, by means of varying hydraulic pressures, a powdered carbon resistance, placed in the charging circuit between the dynamo and the battery, which keeps the charging voltage practically constant. The house is supplied with 350 incandescent lamps, varying in candle power from 10 to 50 each, two arc lamps, and three fan motors. Current is also supplied to Mr. Brush's private laboratory. The plant has

been in constant operation for the past six years, and it is found after continued use that the amount of attention necessary to keep it in working condition practically amounts to nothing.

An important feature of this experiment is the good behavior of the storage battery. Of the 408 cells in constant daily use, Mr. Brush informs me that not one shows serious signs of failure, and that all are in good, serviceable condition. He has never renewed a plate since the battery was first set up. One could scarcely ask for stronger proof of the ability of storage batteries to meet the requirements of this service.

From a commercial point of view the only criticism to be made in connection with Mr. Brush's plant is the great first cost which the complex construction necessarily involves. However much they may appreciate the convenience and desirability of possessing such a home luxury, there are comparatively few householders that can afford the expense. The question naturally arises, therefore, cannot the same results be secured without the expense?

It was in the effort to answer this question in the affirmative that the writer, some two years ago, undertook a series of experiments which have already yielded such promising practical results that he is encouraged to believe the answer complete.

The three obstacles which, in the past, have stood in the way of commercial success in this particular line of electrical development, viz.: expensive and inefficient windmills, the need of a dynamo especially designed for variable driving speeds, and costly, as well as unreliable, storage batteries,—are no longer formidable.

Since Sir William Thompson first called attention to the subject in 1881, there have been many improvements in windmill construction, all of which have tended to increase its efficiency, while decreasing the cost of manufacture. Steel is taking the place of wood as a material, both in tower and wheel, with less dead weight in the moving parts, and correspondingly greater speed. The power lost through friction is therefore diminished. Another feature is the rapidly increasing number of "geared" mills, manufactured each year; the reciprocating or "pumping" mill not being suited to the work of driving machinery.

The *useful efficiency* of the best types of geared mill now on the market, compares most favorably with that of the best simple steam-engines, when the total amount of energy available in each case is considered, and the difference in first cost is not so great as is popularly supposed. The windmill costs nothing for either fuel or attendance, while the allowance for depreciation is less than half that allowed for the engine.

The following table showing the actual useful horse-power developed by windmills of different sizes, is the result of my own experiments, made with wooden wheels, driving a differentially wound dynamo. It will be found to be a conservative though fairly accurate one, for the best mills of this class. For the best steel mills the figures should be increased 20 per cent.

Diameter of Wheel.	Windmill. Actual Useful Horse-power Developed.						
	8-M. Wind.	10-M. Wind.	12-M. Wind.	16-M. Wind.	20-M. Wind.	25-M. Wind.	30-M. Wind.
12-foot Wheel	0	$\frac{1}{8}$	$\frac{1}{4}$	$\frac{1}{2}$	1	$1\frac{3}{8}$	2
14 "	0	$\frac{1}{4}$	$\frac{3}{8}$	1	$1\frac{3}{4}$	$2\frac{3}{8}$	3
16 "	$\frac{1}{8}$	$\frac{3}{8}$	$\frac{1}{2}$	$1\frac{1}{2}$	$2\frac{1}{4}$	$3\frac{1}{4}$	4
18 "	$\frac{1}{4}$	$\frac{1}{2}$	$1\frac{1}{4}$	2	3	4	5
20 "	$\frac{3}{8}$	$1\frac{1}{4}$	2	3	4	$5\frac{1}{2}$	7
25 "	$1\frac{1}{8}$	$1\frac{3}{4}$	3	$4\frac{1}{2}$	6	8	10
30 "	2	3	4	$5\frac{3}{4}$	7	9	12
35 "	3	4	$5\frac{1}{4}$	$6\frac{3}{4}$	$8\frac{1}{4}$	$10\frac{1}{8}$	14

By "useful horse-power," is meant that actually applied to the shaft of the armature, as shown by the voltmeter and ammeter, allowing 500 watts per horse-power.

Next to the windmill, the most important factor in the problem is the dynamo. The service conditions here are so radically different from any found in ordinary practice, that a special machine is a necessity. The speed is never for a moment constant, and the variations are both sudden and great, with corresponding fluctuations in the current produced.

Heretofore, the effort has been to regulate for changes in speed, by some form of resistance device placed in the field circuit, and operated either by a centrifugal governor or an electro-magnet, the brushes being shifted automatically as the load changed. Such a construction is objectionable for two reasons, viz.—it adds to the number of delicate parts, and hence to the chances of a break-down, and it also greatly increases the cost of manufacture.

I have found that it is possible to secure the most satisfactory regulation by a simple, differential winding of the field. The dynamo is compound wound, with the compound, or series coil reversed. The field is therefore strongest when no current passes through this coil, (*i. e.*, when the line circuit is open) and it becomes weaker as the current out-put increases; thus reversing the usual practice.

With the proper number of turns of wire in the compound coil, it

is possible to operate this machine safely between any given speed limits, but since the regulation must necessarily be secured at the expense of efficiency, it is not wise to make these limits too great. On the score of economy, it is well to so adjust the mill itself that the maximum speed of the dynamo is never more than double the average working speed. With carbon brushes of good size, and a properly designed armature and commutator, there is no necessity for any movement of the rocker arm under the most violent fluctuations of load.

This method of regulation is as effective as it is simple. It is peculiarly well adapted to windmill service since the working or charging circuit must always contain a storage battery, and the resistance of the line is necessarily small. A slight rise in the voltage, therefore, produces a very considerable increase in the regulating current, and hence the lamps are never subjected to extremes of pressure, however much the speed may vary.

The automatic cut-out used between the dynamo and the battery is simple and inexpensive and never fails to do its work. It closes the charging circuit when the voltage of the dynamo equals or exceeds that of the battery, and opens it the instant these conditions are reversed.

The third essential element in our generating plant is the storage battery. Experience shows that a wind velocity of at least six miles per hour is necessary to drive a windmill. Consequently, there are hours, and even days, at a time when it cannot be depended upon to do effective work. The storage supply must therefore be sufficient to tide over such periods of calm.

Where windmills are used to pump water, it is the general practice to have the storage tank large enough to contain from three to five days' supply. The same rule should hold in determining the storage capacity for the electric plant. Much, however, will depend upon the location of the mill. Along the seacoast, or on the prairies of the west, where the wind blows almost constantly, a three days' supply is ample, but in many other parts of the country a full week's reserve may be occasionally needed.

There is a constantly growing demand for small, isolated lighting and power plants, which can be installed at a moderate cost, and cheaply maintained. The demand is naturally greatest in the suburban, and nearby country districts, particularly those surrounding our larger cities, where the luxury of electric light is fully appreciated and would be secured if the expense were not prohibitive.

It is in this field that the windmill, as a source of cheap power, must find its greatest usefulness. It is admirably adapted to the work, and, in the opinion of the writer, such an electric plant will be found to be more economical than any other, where the number of lights sup-

plied is not too great. The cost of operation is practically limited to the two items of depreciation, and interest on money invested, since no attendance, beyond occasional inspection, is necesssary.

A plant which has been in very successful operation at the summer residence of Mr. Geo. E. McQuesten, at Marblehead Neck, Mass., during the past six months, is the best practical illustration of what has recently been accomplished in this line. The experience of Mr. McQuesten is the more valuable, because of the fact that for three summers previously he had used a steam plant to do the same work, and he is therefore in a position to judge impartially as to the relative economy of the two.

The steam plant (including engine, boiler, dynamo, and 46 cells of storage battery) was originally installed at a cost of $1000, and was in operation six months in the year for three years. From data kindly furnished by Mr. McQuesten, I find that the average operating expenses during this time, including cost of fuel, repairs, oil and other supplies, but exclusive of interest charges, depreciation and attendance, amounted to one cent per lamp hour. Depreciation at 10 per cent. would amount to $100, interest at 5 per cent. to $50, and cost of attendance to at least $75 more per annum. The total number of lamps supplied was 75,—60 in the house and 15 in the stable.

The present windmill plant was completed in May last. Mr. McQuesten personally superintended the construction, designing and arranging every detail, and has since taken the greatest interest in its successful operation. The windmill is an "Eclipse mill," with a wooden wheel 20 feet in diameter, mounted upon a substantial tower of wood 75 feet in height. At the foot of the tower and enclosed within the limits of its base, is a neat frame building which contains all the electrical apparatus. The vertical shaft of the mill is geared to a short counter-shaft within this building, and the dynamo is belted directly to the counter-shaft.

The dynamo is rated at 2 K. W. at 1200 revolutions, and is wound for variations of speed between 750 and 1500 revolutions per minute. It is too small for a mill of this size and at times during the summer has been greatly overloaded. A 3 K. W. machine would have been better. The cut-out is contained in a small box near the dynamo. The storage battery consists of 46 Bradbury-Stone cells, connected in series, each cell having a capacity of 200 ampere hours. Ninety volt 16 candle power lamps are used throughout. Near the base of the tower is a small experimental laboratory and machine-shop which contains tools for working in iron and wood, testing instruments, etc., also an electric motor for power purposes, and 12 incandescent lamps run from the battery.

In addition to supplying light to his own residence (60 lamps), his stable (15 lamps), and laboratory (12 lamps), Mr. McQuesten has extended the wires some 200 feet to the home of a relative, where 50 lamps are supplied.

The cost of the plant, complete, including mill and tower, dynamo, cut-out, storage battery, wiring, except house wiring, and the necessary labor and materials, was $1800. During the six months that it has been in operation, it has not once failed to supply all the light needed, and has cost nothing for maintenance, beyond the price of the oil used for lubrication.

Comparing the two plants we have:

Steam plant, supplying 75 lights, original cost, $1000; depreciation—yearly cost—$100; interest, $50; attendance, $75; operating expenses (1 cent per lamp hour), $100 (six months of summer); total yearly cost, $325, or $4.33⅓ per lamp per year.

Windmill plant, supplying 127 lights, original cost, $1800; depreciation, year—(5 per cent. on mill, and 10 per cent. electrical apparatus) $130; interest, $90; attendance (occasional inspection), $20; operating expenses (oil, etc., estimated), $10; total yearly cost, $250, or say $2 per lamp per year.

The above is certainly a remarkable showing in favor of the windmill as a source of power in the generation of electricity for domestic use.

This field is a broad and fertile one. Proper cultivation alone is needed to produce an abundant harvest.

ALUMINUM, THE SUPERABUNDANT METAL.

By Henry Wurtz, Ph. D.

IN this article facts will appear, convincing to rational minds, that aluminum is destined in the near future to enter abundantly into the affairs of men, to reach a production comparable with those of tin and copper, and rapidly to become as cheap as these metals, at least for equal bulk.

So far as we know the solid portions of our planet, more than half is oxygen. This no chemist believes to possess a metallic form. Of silicon, the next element in order of abundance, we cannot say the same, as it undeniably forms many metallic alloys, and may yet be discovered in metallic form. The element next in abundance, aluminum, forms certainly as much as 8 (possibly 10) per cent. of the shell of the earth of the sixteen miles in thickness that we can explore. It is therefore by far the most abundant of the known metals. The chemical history of the formation of the earth's crust shows that aluminum is exceptional in several respects. Though not difficult to dissolve in water by the aid of alkalies, yet natural and even alkaline waters contain none. Hence it does not, like other abundant elements, flow from springs, pass through rivers, and diffuse throughout the ocean. Though abounding in soils, it is not absorbed by plants that grow thereon, proving its insolubility in those plant excretions and products of decay which dissolve other mineral matters. Hence, during the vast erosions, degradation, and sifting of the materials of continents, aluminum has remained in concentrated forms, and in the débris is possibly as abundant as the all-pervading element silicon. The commonest mica, muscovite (potash-mica), is its most abundant ore, containing 20 per cent. of aluminum. Clay contains 21 per cent.; dehydrated clay, 24½ per cent.; emery, 31½ per cent.; corundum, 52½ per cent.; and bauxite (now the favorite ore), 28 to 31½ per cent. Bauxite was formerly found only in Europe, but recently was discovered in Georgia, Alabama, and Arkansas. It is hydrate of alumina with a little iron oxide and silica. It has to be converted into pure alumina, and therefore has but small advantage over clays, which in time, on a larger scale, will supplant it. But now bauxite is the only important ore.

Davy's discoveries, in 1807–8, of the metals of soda and potash by electrolysis led to efforts by himself and others to get the metal which they knew must be in alumina. It is, however, held so fast in the clutch of oxygen that it was not till 1826 that the first clew was found. Oersted, of Copenhagen (who six years before had made his grand

discovery of electro-magnetism, now of such ruling importance in this very field), first produced aluminum chloride, sought for in vain before by others. He at once attempted its decomposition, selecting as his agent amalgam of potassium, Berzelius having then recently isolated barium with this. Oersted failed, for a reason no one could have foreseen. This was because mercury destroys aluminum. In 1828 the German chemist Wöhler repeated this, luckily using potassium itself, and metal aluminum was born at last into the hands of man.

In 1854 the great French chemist, Deville, began experiments on aluminum and produced enough to be made into shapes illustrating its properties. He worked first with potassium, then with sodium, and finally by electrolysis. At this particular time Bunsen, in Germany, was experimenting also by electrolysis. The discovery of electrolytic aluminum lies therefore between these two. Some make the claim for Bunsen, as he had previously obtained magnesium in the same way. Deville exhibited his "silver from clay" (so labeled) at the Paris exhibition of 1855, where it excited great attention and wonder. In the second French exhibition (1867) large ingots appeared, and various wrought products. In America, Castner, in 1886, brought out his sodium process, making aluminum at a cost of 18 cents a pound, which was realized on a large scale in England. We should ere this have had cheap aluminum by sodium but for the amazing advancement of electro-magnetic machinery. This gave birth to the American Cowles process for alloys, and the American Hall and French Heroult processes for rich metal, which now control the aluminum industry.

The physical and chemical qualities of aluminum, commercially pure, containing less than 2 per cent. of iron and silicon, are as follows: Silver-white, with a shade of violet or lavender; when "matted" by an alkali followed by an acid it exhibits a beautiful dead-white surface. It takes a high polish and burnish. Gravity ranges from 2.56 for ingots, to 2.61 for wrought and rolled, and 2.67 to 2.8075 for foil. While a cubic foot averages 163 pounds, one of silver weighs 656 pounds, or four times as much. At present prices of the two—aluminum 70 cents per pound, avoirdupois, and silver 60 cents per ounce, troy—spoons, forks, cups, etc., of silver should cost 12½ times, and with aluminum at 50 cents per pound (as in Europe) 19 times, as much as those of aluminum. It ranks in malleability and ductility almost with gold and silver, and can be drawn into fine wire and tubes, and forged, stamped, pressed and "spun" into all shapes, and beaten as thin as gold, but curiously does not become translucent like leaf-gold. When forged, drawn, or stamped cold, it becomes, like soft iron, hard and rigid, especially when other metals are present, and requires frequent annealing. When perfectly pure it resem-

bles iron, gold, silver, copper, etc., in being too soft for many practical uses, for which it has to be hardened by a little iron, or especially with silicon; this latter bearing to it the same relation as carbon to iron, conferring steely qualities of hardness and strength. Its electric conductivity is uncertain, but probably about half that of copper, for bulk. For weight, the ratio is 57 for copper to 100 for aluminum. Its heat conduction approaches the same ratio. It resists oxidation, though in time a thin film, readily rubbed off, dulls its luster. It resists saliva and organic liquids; hence it is adapted for dental plates and surgical uses. For culinary and table-ware it is far better than silver, which is rapidly corroded by sulphur compounds. Alkalies and hydrochloric acid dissolve it rapidly. Mercury, made to enfilm it, causes it to oxidize energetically. Aluminum melts between silver and zinc, the point being uncertain. Thus Mallet says the impure commercial aluminum melts more easily than chemically pure; while Carnelly states that with 0.5 per cent. of iron it melts about 1290° F., and with 5 per cent. of iron a hundred degrees higher. These statements are hardly reconcilable. It volatilizes in the electric arc, but not in any furnace fire. It is melted in black-lead pots. In clay crucibles it takes up silicon. Fluxes contaminate it, and a covering of charcoal powder suffices. The specific heat is twice that of iron, quadruple that of silver, and nearly seven times that of gold. Hence, though less conductive of heat, it feels far colder than these. The latent heat of liquefaction is undetermined, but large, from the long time required for fusion. Aluminum is remarkably sonorous, ringing like silver.

As to the methods of getting aluminum, only the most prominent in use—two in America and one in Europe—can be explained in the space here available. The Cowles process (American, 1885) produces alloys only, mainly aluminum-bronzes or copper alloys. An arc between very large carbon electrodes is diffused throughout alumina, corundum, or other ore, mixed with granulated copper and carbon. It is in part an adaptation of the first electric furnace of the British patent granted January 31, 1862 (to E. H. C. Monckton), specifying the application of electric currents to "the reduction and fusion of ores and metals that are otherwise intractable, by intensifying the heat of ordinary furnaces, as for example, the reduction of aluminum." The alumina melts, and is deoxidized by the carbon, the aluminum being even converted partly into vapor by the heat of the arc. Such vapor is absorbed by the copper to the amount of 30 per cent. or more. This rich alloy is subsequently melted with more copper to bring the aluminum to the proportion desired. The Hall process (American, filed in 1886), operated by the Pittsburgh Reduction Company, is to employ also at Niagara 6500 electrical horse-power. This company

now monopolizes the American trade in pure and "commercially pure" aluminum. The process is the electrolysis of fused cryolite (or other fluorides) kept saturated with pure alumina dissolved at intervals. Fusion is maintained by resistance of the cryolite, which is a poor electrolyte, and can therefore be regulated by more or less alumina, which decreases the resistance. If the fluoride bath be pure, the metal obtained should also be pure; but as native Greenland cryolite is used, for economy, its contaminations, silicon and iron, are introduced. Nevertheless the Pittsburgh company now advertise metal of 99.6 per cent. at special rates; ingots over 98 per cent. for 58 cents per pound by the ton; 60 cents for 100 pounds; and for less, 63 cents. Also 94 per cent. ingots (for siderurgical uses), at 50, 53, and 55 cents respectively. The baths are in cast-iron pots lined with carbon as cathodes, with carbon anodes, which are gradually consumed by the oxygen of the decomposing alumina, and require renewals. If bronze is made, the anodes are copper. The temperature is below that of fusion of copper. The aluminum realized is 94½ per cent. of that added as alumina. Each bath yields one pound of aluminum per hour, with a consumption of 18.1 electrical horse-power hours, and of one pound of carbon anode. The Heroult process (French, 1887), when making pure aluminum, appears practically similar to that of Hall, but without solvent for the alumina fed in, this being kept in fusion by the arc, as in the Cowles apparatus. The carbon anodes of course are consumed. For bronzes, the fused alumina rests upon melted copper, which becomes highly charged with aluminum. It has been operated since 1888 by water-power on a great scale at Neuhausen, Switzerland, at the Falls of the Rhine, by the Industrie Actien-Gesellschaft, who advertise aluminum (grades not stated) for 45 cents per pound. It is operated also at Froges, in France, by water-power.

Well polished aluminum yields in luster and beauty to no other metal, and, exposed to close air with its sulphurous taints, retains polish where silver tarnishes at once. Castings and sheets acquire on a steel-brush wheel a finish equal in beauty to polishing. Smooth surfaces are matted by blackening with potash lye, pickling with sulphuric and nitric acids mixed, washing and drying in sawdust. In burnishing, vaseline is used, also borax solutions. Aluminum foil, rolled to 1/2000 inch, is superseding silver for decoration. The best temperature for working is 400° to 600° F. Aluminum is annealed at red heat with slow cooling. The best tubing has been drawn abroad. Such light, strong, incorrodible, infrangible tubing is of immense importance. In casting, aluminum must not be overheated, as it then occludes gas and forms blowholes. As before stated,

Carnelly makes the melting point near 1300°; Roberts-Austin puts it away down to 1120° F. Aluminum foundry-work is rapidly increasing. Hollow-ware is cast $\frac{1}{16}$ inch thick, which bends almost double without cracking. Molds are best operated by air-pumps with asbestos pistons, both for vacuum and for pressure, by the Smith process. Castings that are thin and sharp, without cavities, result. Soldering is just being learned, and alloys and fluxes too numerous to mention are being tested. Electric welding for wires, rods, and sheets is likely to be preferred. As a flux, silver chloride is claimed to answer even with common soft solder, but something cheaper must be found. Plating cheaper and stronger metals—steel, copper, aluminum-bronze, etc.—with pure aluminum is an open and fertile field. Chasing, embossing, and engraving are matters for the artist rather than the artisan.

The uses for the lower grades of aluminum are as yet comparatively restricted, but will soon absorb, for ornamental uses only, large and increasing amounts. The veneering of non-metallic surfaces and the plating of metallic surfaces will be important also for protective purposes. Here its persistence, resistance to corrosion, color, softness, and pliability are paramount even to its levity. The case of pure aluminum is analogous to that of pure iron, which as yet is little more than a curiosity. For leaf, fine wire, medals, medallions, coinage* (this alone would lead to a very great expansion of pure aluminum manufacture), statuettes, ornamental castings, cards, tickets, baggage-checks, thread for textile fabrics and lace, plane and concave mirrors, picture frames, combs, buttons, book bindings, and generally for all cases in which color and durable luster will tell, the pure metal must come into demand. It will be required also for surgical uses and as a laboratory agent.

Uses of the "commercially pure" metal—say 94 or 95 per cent.—must soon become more numerous. From a feasible mode of coat-

* This is an application which, for "token" coins, should be adopted by all nations, now that the supply of aluminum has become but a question of demand. Professor Richards, in his second edition (p. 370), condemns the use for coins on very remarkable grounds, one being that a coined metal should have a "value as nearly fixed as possible." To mere tokens, this is totally inapplicable. What is needed for these is exactly such a metal as aluminum. Richards refers to experiments of the United States government in 1865 on aluminum coinage, and surmises that the "results were not sufficiently successful." He is in error here. They were in the highest degree successful. The then secretary of the treasury, Mr. Chase, intended to recommend favorably to congress half-dime coinage of aluminum, but when he was appointed to the supreme bench the project fell through. John Torrey, then United States assayer in New York, brought the subject before the government. Dr. Torrey and the officers of the United States mint were highly pleased with the coins—which were at least equal in beauty, if not superior, to the aluminum medallions, or "Chicago memorials," so abundantly distributed at the late World's Fair. The writer, with whom the project originated, built sodium-furnaces, made sodium, and was building aluminum-furnaces, guaranteeing to supply enough metal, without which Secretary Chase would not have moved in the matter. It is stated that samples of these coins and medals from Dr. Torrey, are now contained in the Lenox library collection, in New York. H. W.

ing iron with such metal, as now with tin or zinc, a very important industry would rapidly rise, in which alloys would also be employed. The principal uses for these grades are now for making alloys and as an addition to molten steel and iron. Whatever is to come hereafter, the largest field for aluminum now is in the form of alloys. An arrangement of these, somewhat in the order of their importance, is thus: alloys with copper (bronzes); copper and zinc (brasses); iron and steel; zinc (for "galvanizing"); lead and antimony (type-metals); manganese; silver; nickel; tin. Others are under investigation. One tenth of the make of the Pittsburgh company in 1893 was sold for making bronzes, being equivalent to 340 tons of bronze of medium grade, and another tenth for alloying with brasses. These bronzes contain from about 2½ to 9½ per cent. of aluminum; the most valuable being a definite compound with 9.36 per cent. aluminum, of a pale "jewelers' gold" color, and gravity 7.534. Another, containing 5 per cent., has so nearly the color of fine gold that experts are deceived. An intermediate compound containing 7.85 per cent. has the color of green gold. These colors rival gold in permanency in the air and slowness of tarnish. The strength of these bronzes equals that of good steel. Cowles's "A1" bronze, made from corundum, tests from 95,000 to 128,000 pounds per square inch, averaging 111,280 pounds. Heroult-process bronzes have stood from 50,000 to 90,000 pounds. Heat has little action on them,—not even a red heat for months. Agents which soil their surfaces, as perspiration, etc., go no deeper. Ductile in the cold, they can be forged at a red heat like iron, and stamped, pressed, and spun into all shapes. Their rigidity is twice to thrice that of ordinary bronze. One drawback is shrinking in the mold when cast, but this is overcome by yielding and plastic cores. As with common bronzes, two or three remeltings are needed to impart the best qualities. Unlike steel, they are softened by chilling. In electric conduction they are close to copper, from which are apparent enormous prospective uses. Alloys with nickel possess a rigidity equal to that of the best steel. Of these the writer has a sample that has stood such tests. Aluminum brasses, like the bronzes, are far stronger, more ductile, less corrodible, and of finer colors than common brasses. Brass with but 4 per cent. of aluminum has stood a strain of 98,000 pounds per inch. In durability under action of heat, however, they are far below the bronzes.

There are no more striking and extraordinary characteristics of aluminum and its alloys than their influences over iron and steel. Metallurgists now admit that if aluminum had no other use, its value in the annihilation of blowholes in casting would make it inestimable. It is found also to soften and toughen iron castings by transmuting

combined carbon into graphite. The explanation is yet in controversy. About 20 per cent. of the Pittsburgh company's make of 1893 (some 70,000 pounds) went to steel melters, with 5 per cent. more to iron founders. As the average per ton of steel is 7 ounces, some 160,000 tons of steel castings were thus made strong and safe in 1893. This is not all; the casting of nearly carbonless iron has been almost impracticable because of the monstrous heats required and the number of blowholes in the product. Aluminum added to such iron, in pasty fusion only, instantly liquefies it, and the casting is totally free from cavities. These are "Mitis castings," known since 1885. These discoveries are revolutionizing the arts of siderurgy.

The future of aluminum should receive some attention. A few statistics—available as yet for but six years—furnish a minimum conception of what is to come. Estimates by the Pittsburgh Reduction Company of American aluminum production from 1888 inclusive, are:

In 1888		19,000 pounds.
In 1889		47,468 pounds.
In 1890		61,281 pounds.
In 1891		150,000 pounds.
In 1892		259,885 pounds.
In 1893		342,705 pounds.
In 1894	(estimated)	642,705 pounds.

This 86 per cent. ratio will doubtless increase, but at this rate only the production for successive years will be as follows:

Year.	Pounds.	Year.	Pounds.
1895	1,185,622	1900	26,394,359
1896	2,205,257	1901	49,093,508
1897	4,101,778	1902	91,313,925
1898	7,269,307	1903	169,843,900
1899	14,190,511	1904	315,909,654

Thus, ten years ahead, with what may be called the juvenile ratio of growth, we may see in 1904 158,000 short tons. Our United States copper production in 1893 was but 161,000 short tons. At present minimum prices, 45 cents per pound, the value of the product in 1904 should be $142,200,000; but none will imagine that this price can hold until then. Ten cents per pound is more probable. This will be near $31,590,000 for the whole make, and no doubt will leave margin enough for the manufacturers and a modest competence for each inventor besides. A reduction has been publicly promised here as soon as consumption justifies it; and the French manufacturers at Froges promise that when sales reach 3000 tons per annum they can sell aluminum at 15 cents per pound,—equivalent for bulk to about 4½ cents for copper, inherently a less valuable metal.

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An A A..Annals of Am. Academy of Political and Social Science. *b-m.* $6. Philadelphia.
A An.... American Analyst. *f.* $1. New York.
A & B....Architecture and Building. *w.* $6. N. Y.
A B D....Arch. Build. and Dec. *m.* $2. Minneapolis.
A C J....Am. Chem. Journal. *b-m.* $4. Baltimore.
A E C U..Asso. of Eng. of Cornell Univ. 1894. Ithaca.
A E R J..Am. Eng. and Railroad Journal. *m.* $3. N.Y.
A G.....Am. Geologist. *m.* $3.50. Minneapolis.
A G L J..Am. Gas Light Journal. *w.* $3. New York.
A J P....Am. Jour. of Politics. *m.* $3. New York.
A J R A..Jour. R'y. Appliances. *m.* $2. New York.
A J S ...Am. Jour. of Science. *m.* $6. New Haven.
A L ....The Architect. *w.* 26*s.* London.
A M.....American Machinist. *w.* $3. New York.
A M & I W.Am. Man. and Iron World. $4. Pittsburg.
A M S.. Aust. Mining Standard. *w.* 30*s.* Sydney.
A R.....Architectural Record. *q.* $1. New York.
A Rev....Architectural Review. *s-q.* $5. Boston.
A S .....Age of Steel. *w.* $3. St. Louis.
A S I E ..An. of Amer. Soc. of Irri. Eng. 1892-93.
A S M E..Am. Soc. of Mec. Eng. *m.* New York.
B ..... The Builder. *w.* 26*s.* London.
B A... .The British Architect. *w.* 23*s.* 8*d.* London.
B B.....Brick Builder. *m.* $2.50. Boston.
B I S....Bul. Am. Iron and St. Asso. *w.* $4. Phila.
B J C....Boston Jour. of Commerce. *w.* $3. Boston.
B M ....Banker's Mag. *m.* 18*s.* London.
B T J ...Board of Trade Journal. *m.* 6*s.* London.
B U W...Bul. of the Univ. of Wisconsin.
C A.....Calif. Architect. *m.* $3. San Francisco.
Can A.. Canadian Architect. *m.* $2. Toronto.
C & B... Carpentry and Building. *m.* $1. New York.
C E .....Colliery Engineer. *m.* $2. Scranton, Pa.
C Eng....Canadian Engineer. *m.* $1. Montreal.
C G.. ..Colliery Guardian. *w.* 27*s.* 6*d.* London.
Ch.....Chautauquan. *m.* $2. Meadville, Pa.
C M.....Century Magazine. *m.* $4. New York.
C M R...Canadian Mining Rev. *m.* $1.50. Ottawa.
Cos..... ..Cosmopolitan. *m.* $1.50. New York.
C R.....Contemporary Review. *m.* $4.50. London.
C T J....Chem. Trade Jour. *w.* 12*s.* 6*d.* Manchester.
D E.....Domestic Engineering. *m.* $2. Chicago.
E.....Engineering. *w.* 38*s.* London.
E A.....Electrical Age. *w.* $3. New York.
E A S....Eng. Asso of the South. *m.* $3. Nashville.
E E .....Electrical Engineering. *m.* $1. Chicago.
E E L....Electrical Engineer. *w.* 19*s.* 6*d.* London.
E E N Y..Electrical Engineer. *w.* $3. New York.
E G.....Engineers' Gazette. *m.* 8*s.* London.

E I.....Electrical Industries. *m.* $1. Chicago.
E L.....Electricity. *w.* 7*s.* 6*d.* London.
El.. .....Electrician. *w.* 24*s.* London.
E M.....Engineering Mechanics. *m.* $2. Phila.
E Mag...Engineering Magazine. *m.* $3. New York.
E M J....Eng. and Mining Journal. *w.* $5. N.Y.
E N.....Engineering News. *w.* $5. New York.
Eng .....Engineer. *s-m.* $2.50. New York.
EngL... Engineer. *w.* 36*s.* London.
E N Y....Electricity. *w.* $2.50. New York.
E P.....Electrical Plant. *m.* 6*s.* London.
E R.....Engineering Record. *w.* $5. New York.
E Rev...Engineering Review. *m.* 7*s.* London.
E R L ....Electrical Review. *w.* 21*s.* 8*d.* London.
E R N Y..Electrical Review. *w.* $3. New York.
E S W P...Proc. Eng. So. of W. Pa. *m.* $7. Pittsburg.
E W.....Electrical World. *w.* $3. New York.
F ... .Forum. *m.* $3. New York.
F D.....The Foundry. *m.* $1. Detroit.
F R.....Fortnightly Review. *m.* $4.50. London.
F W.....Fire and Water. *w.* $3. New York.
F'y.....Fairplay. *w.* 32*s.* 6*d.* London.
G E M...Gas Engrs' Mag. *m.* 6*s.* 6*d.* Birmingham.
G & F....Garden and Forest. *w.* $4. New York.
G M.....The Geol. Mag. *m.* 18*s.* London.
G R.....Good Roads. *m.* $1. New York.
G W.....Gas World. *w.* 13*s.* London.
H & V....Heating and Ventilation. *m.* $1. N. Y.
I A.....Inland Architect. *m.* $5. Chicago.
I Age....Inventive Age. *s-m.* $1. Washington.
I & I.....Industries and Iron. *w.* £1. London.
I & S.....Iron & Steel Trades' Jour. *w.* 25*s.* Lond
I C B... .Carpenter and Builder. *w.* 8*s.* 8*d.* London.
ICT... ..Iron and Coal Trades. *w.* 30*s.* 4*d.* London.
I E.....Indian Engineering. *w.* 18 Rs. Calcutta.
I I G.....Iron Ind. Gazette. *m.* $1.50. Buffalo.
Inv.....Invention. *w.* 11*s.* London.
Ir Age..Iron Age. *w.* $4.50. New York.
Irm.. ...The Ironmonger. *w.* 10*s.* London.
I R W...India Rubber World. *m.* $3. New York.
I S F.....Industry. *m.* $2. San Francisco.
I T R....Iron Trade Review. *w.* $3. Cleveland.
J A C S..Jour. Am. Chem. So. *m.* $5. Easton.
J A E S. Jour. Assoc. Eng. Soc. *m.* $3. Chicago.
J A N E..Jour. Am. Soc. Naval Engineers. *qr.* $5. Washington.
J F I.....Jour. Franklin Institute. *m* $5. Phila.
J G L....Journal of Gas Lighting. *w.* London.
J M W A..Jour. of United Metal Workers of America. *w.* $1. N. Y.
J N E W..Jour. N. E Waterw. As. *q.* $2. New London.
J P E.....Jour. Polit. Economy. *q.* $3. Chicago.
J S A... Journal of the So. of Arts. *w.* London.
L A.....The Landscape Architect. *m.* $1.50. Rochester.
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M.....Machinery. *m.* 9*s.* London.
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P Eng...Practical Engineer. *w.* 10*s.* London.
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Pr.....Power. *m.* $1. N. Y.
P S M....Popular Science Monthly. *m.* $5. N. Y.
R A.....Railway Age. *w.* $4. Chicago.
R C J....Railroad Car Journal. *m.* $1. New York.
R E M....Railway Engineering and Mechanics. *m.* $1. Chicago.
R G .....Railroad Gazette. *w.* $4.20. N. Y.
R of R...Review of Reviews. *m.* $2.50. New York.
R P L....The Railway Press. *m.* 7*s.* London.
R R.....Railway Review. *w.* $2. Chicago.
R W.....Railway World. *m.* 5*s.* London.
Ry T.. . The Railway Times. £1. 5*s.* London.
S... .....Stone. *m.* $2. Chicago.
S A.....Southern Architect. *m.* $2. Atlanta.
San.....Sanitarian. *m.* $4. Brooklyn.
Sc A.....Scientific American. *w.* $3. New York.
Sc A S...Scientific Am. Supplement. *w.* $5. N. Y.
Sc M....Scribner's Magazine. *m.* $3. New York.
Sc Q.....Scientific Quarterly. *q.* $2. Golden, Col.
Sea.....Seaboard. *w.* $2. New York.
S In.....Stevens' Indicator. *qr.* $1.50. Hoboken.
S J E....Sibley Jour. of Eng. *m.* $2. Ithaca, N. Y.
S L.....Steamship. *m* Leith, Scotland.
S M.....ScientificMachinist. *s-m.* $1.50. Cleveland, O.
S M Q....School of Mines Quarterly. $2. N. Y.
S R.....Sanitary Record. *m.* 10*s.* London.
S R E N..St. R'y. Elec. News. *m.* $2. Minneapolis.
S P.....Sanitary Plumber. *s-m.* $2. New York.
S R G....Street Railway Gazette. *w.* $3. Chicago.
S R J....Street Railway Journal. *m.* $4. New York.
S R R.. .Street Railway Review. *m.* $2. Chicago.
S V.....Safety Valve. *m.* $1. New York.
T ... .Tradesman. *s-m.* $2. Chattanooga, Tenn.
T A I E E.Trans. Am. Ins. Elec. Eng. *m.* $5. N. Y.
T C E....Trans. Am. Soc. Civil Eng. *m.* $10. N. Y.
T Q.....Technology Quarterly. $3. Boston.
Tr.....Transport. *w.* £1. 5*s.* London.
Tr A M E.Trans. Am. Ins. of Mining Eng. N. Y.
T W A .Trans. of the Wis. Acad. Madison.
W A....Western America. *m.* $1. Omaha.
W E.....Western Electrician. *w.* $3. Chicago.
W R ....Westminster Review. *m.* $4.50. London.

ARCHITECTURE & BUILDING

Housing of the Poorer Working Classes.

THE much mooted problem of designing and supplying houses to the poorer working classes (such that, while in points of luxury and elegance a good deal inferior to those that can be afforded by people of moderate means, shall yet be much more than mere hovels, and shall at least supply conditions not tending to invite, foster, and spread disease, and which will enable occupants to live in reasonably good health and cleanliness) is still a fruitful theme of discussion at nearly every meeting of architects or engineers where general sanitation is debated. At the recent meeting of "The Sanitary Congress at Liverpool," (under which title *The Builder*, London, and other English architectural publications are serially publishing notices of the proceedings) this subject came up, three papers were read upon it, and a lengthy discussion followed. What was said in the papers and in the discussion does not seem to help much toward a final solution of the question. The poorer working classes were defined by one gentleman who took part in the discussion as comprising those whose income does not exceed one pound a week. He took the ground also that poor people cannot afford more than one-fifth of their earnings for rent. Taking this as a basis, it will be seen that the problem reduces to the construction of clean, healthy buildings that can be rented at about a dollar a week (U. S. money), and which, at this rate, will return the interest on capital invested. Taking into account repairs and taxes, in order to effect such a return this rental must represent about 10 per cent. per annum of the total investment for both the building and its site, which brings the total investment down to $520 for each such dwelling. In populous cities where land is very dear, after the purchase money for site has been deducted, not a very large sum would be left for building.

The facts brought out in the discussion were quite the reverse of hopeful. The status of the question was well presented in the remarks of Sir F. S. Powell who in opening the discussion declared that the paper read had dealt more with minute technicalities than with the general features of the question, but that what had been said made it clear that the results of the experiments so far made were not encouraging. He hit the nail exactly on the head, by saying that "the cost of providing dwellings in which the poorest of our people could live in decency, not to say in comfort, was too high for their wages." The logical conclusion from this is that if the working poor are to be enabled to live even decently, it must be done through charitable aid, unless their wages can be raised. Only better wages can prevent this class from ultimately merging into the pauper class, if they are to live on any higher plane than animals. The pauper class is already too large, and the fact that it is so indicates a failure in some part of the social scheme. If the widely accepted economic principle that wage earnings tend constantly toward the point of bare subsistence be taken into account, it follows that the poorer working class must continually increase; and the difficulty in planning houses to enable them to live in decency will increase rather than diminish. Ergo, unless wages are to be raised it is useless for architects or sanitary congresses to bother their heads any more with the subject.

Dr. Sykes (Medical Officer of Health of St. Pancras) referred to the aspect of this perplexing question in London, where half a dozen large companies were engaged in trying to solve it. The experience was the same. "The large blocks did not pay 3 per cent., and the London County Council had been obliged to increase the price of their dwellings because they could not pay the 3¼ per cent. interest on the money laid out. In London no one would venture to fix so low a rent as 1s. a room. The

question was more than a question of cost of land, it was a question of the amount of accommodation to be given. Were four rooms necessary? By means of what Mr. Blashill had felicitously called associated houses was it not possible to reduce the necessary accommodation to one room? Under present conditions three rooms was the minimum number in London. They must have a living room, one or more bedrooms, a scullery and washhouse. The minimum at 2s. 6d. a room would be 7s. 6d. per week. If Liverpool could not make these houses pay, how much less hope was there of London doing so?

Mr. H. Collins (District Surveyor, City of London), who said he had special experience of this class of buildings, thought that in Liverpool there must be gross mismanagement somewhere. He could point to a large number of such buildings paying four or five per cent. interest. He was the architect of blocks of buildings in Canonbury and Deptford which paid from six to seven per cent. "The return was a matter that depended entirely on the management. In a block of buildings in which three families resided, if a child of any of them damaged a brick, the whole of the families were warned that if it recurred they would all have to go. The warning was generally sufficient." Mr. Vigors of the Peabody Fund, had gone into an elaborate investigation to ascertain the lowest rent which could be demanded, and he found that it was 10½d. per room. A client of his was about to invest 30,000 or 40,000 pounds under his direction in such property, not from philanthrophic motives, but for investment. On the Rothschild property the dividend paid was 4 per cent., at Waterloo, 4 per cent., East London, 4 per cent.

Dr. Sykes—Out of capital?

Mr. Collins—The Rothschilds are not the kind of people to pay dividends out of capital.

Mr. C. S. Pain (Liverpool) protested against the heretical opinions he had heard broached in the Congress under the ægis of the Sanitary Institute, He had just heard philanthropy spoken of as discreditable. "One sapient president had suggested a return to back-to-back houses; another sanitarian advocated that abomination the slop-closet; and now all were to live in one room. Was it not time for the Sanitary Institute to disclaim such unsanitary teachings as these?"

It will be seen that there was plenty of disagreement; the only proposition upon which no dissenting voice was raised was the general one that "something must be done." This proposition has so long been accepted that there does not seem much benefit in repeating it, yet the fact that it was the outcome of the debate at the congress seems to indicate the desperate character of the problem of housing the very poor in large cities. May it not be that the difficulties of this problem arise from an imperfect statement of its terms? Why should there be an increasing number of the very poor congregating in large cities to be housed? Is urban life better adapted to the condition of abject poverty than rural life? If dwellings were erected on cheaper land away from cities, could not the class whose near approach to pauperism and crime is regarded as a public danger keep themselves better housed, better fed, and in a better sanitary condition than is possible in a populous town where ground rent must absorb so much of the little they can earn? Why is it that they can earn only so little? These questions first satisfactorily answered, it would perhaps be easier to solve the problem of housing the very poor.

Testing Building Stone.

A PAPER read by F. Lynwood Garrison, Assoc. M. Am. Soc. C. E., at the annual convention of the American Society of Civil Engineers, has such an important bearing upon all architectural and engineering work in which stone is employed, that perceiving this, it has been reprinted during the current month by several publications more or less representative of engineering and architecture. It contains information upon the structural peculiarities of stone, and its fitness for use as constructive material, that every engineer and

architect ought to know, but of which it is safe to say, many practicing these professions have very little knowledge.

After its perusal many who have relied upon hitherto used methods of testing stone for ascertaining its fitness for building, will acquire and retain a salutary skepticism of the indiscriminate value of such tests, and will be more cautious in founding final judgments upon them. It is asserted that "at least an elementary knowledge of mineralogy, the study of which has unfortunately not been included in the training of most civil engineers and architects, is needed in order to be able to arrive at correct conclusions as to the value of different kinds of stone for building purposes." The fact is emphasized that "all stones or rocks are compounded bodies, often exceedingly complex, composed of aggregations of various mineral substances whose individual nature and their respective influence upon one another should be understood as far as is possible to arrive at a proper appreciation of the whole." A notable point is the advocacy of the use of the microscope, in the examination of stone, rather than entire reliance upon methods hitherto more commonly employed, though the latter are by no means excluded. These are gone over in detail, pointing out wherein they are liable to error through want of proper skill or care in applying them. In discussing these latter points, the following topics are treated: Form of specimens; cushions; bed or natural position; transverse strength; elasticity; porosity; action of frost; specific gravity; hardness; destructive agents; chemical tests and seasoning. A note is appended upon the bibliography of the subject, in which important literature of the subject is named, together with some that only indirectly bears upon the subject. Mr. Lynwood does not claim completeness for this list of publications, stating that there are a number of German publications which were inaccessible to him.

"The practical value of microscopical examinations of stone is much greater than that of ordinary metallurgical productions. In the one case we have a natural production about which we can do nothing without an investigation. In the other case we have an artificial material made for a distinct and definite purpose, to effect which we must needs know more or less of the characteristics and relative reactions of the individual elements constituting the desired compound.

"The tests ordinarily applied to building stone, to determine its physical properties, although few in number, are in some instances rather complicated and often unreliable. The first and most essential is to determine the structure and character of a stone, to know whether it be granite, sandstone, quartzite, or something else. Although an expert can usually determine at a glance to which, if any, of these groups a particular stone belongs, it is frequently possible to determine the precise lithological character only by a microscopical examination. Thus, for instance, there is a class of Cambrian rocks commonly called sandstones (Potsdam?) that are not sandstones at all, but are hard, compact rocks known as quartzites, which have been derived from sandstones by metamorphic action. The essential difference between a sandstone and a quartzite lies in the presence of secondary silica between the quartz granules comprising the latter; the presence of this secondary silica or quartz can be determined for a certainty only by microscopical means. The microscope is not only useful in determining the structure of a stone, but it has an even greater practical value in making it possible to detect the presence of deleterious substances such as pyrite, and marcasite (iron sulphides) or other minerals whose chemical composition is affected by atmospheric agencies and thus exert a deleterious effect upon the stone. The application of the microscope to this, as to every purpose, requires some skill and training, which may, however, be readily acquired by any one to whom the subject is of sufficient interest, microlithology being thoroughly treated in standard works available to all." Microscopical study should be pursued under the guidance of a competent teacher, books on microlithology hardly being competent to take the place of a living instructor.

Competitive Plans.

WITH reference to the system of competitive plans, as now practiced, architectural publications have said a good deal of late by way of protest against it; but interest in the subject will continue so long as the abuses of the system are felt as they now are. One argument in favor of the system is that beginners in the profession sometimes are able thus to obtain work which otherwise they have little chance to obtain. But there is little doubt in the minds of thoughtful men that a better system could be evolved, which while it would obviate the annoying waste of time and effort that now obtain, would not increase disadvantages which young men in all professions encounter before they are able to gain a reputation that in itself brings business. Under the title, "The Pernicious Practice in Selecting Competitive Plans," *The Southern Architect* in its October number attacks the present system vigorously and promises to conclude what it has to say in its November number. In lieu of the system now in vogue, a method favored by many is advocated.

"How much better would open competition be at all times to a limited number of the profession, with remuneration to cover actual expense entailed, without concealment of names, and designs to stand on their own merit as to beauty, utility, economy, symmetry, and cost as decided by an expert appointed to act with a committee! And after the award has been made to hang the designs for public inspection, it must be admitted that the present system produces an effect the very reverse of what is intended, and often ends in a disgusting quarrel, newspaper controversies, and shameful reflections on many concerned. If the merchant can sell his rejected goods for something to the public, the architect cannot sell his designs (no one building would ever suit the exigencies of locality and of new surroundings); although plans have cost months of slavery, office and traveling expenses, they will fetch nothing. They may be the grandest conception of good taste, yet they are useless."

There can be but little doubt as to the immediate salutary effect of such a method as it is here proposed, and it would be very desirable to have it extended to all competitions in the building trades as well.

Woman in Architecture.

THE graduation of a young woman from the Maryland Institute who, it is asserted, intends to adopt architecture as a profession, and the announcement that the Cooper Institute (New York) trustees intend to establish classes in architecture for women, have called forth expressions both of approval and disapproval from our contemporaries. *Architecture and Building* (Oct. 6) looks upon this project as one that promises much for women, if not for the advancement of the art. Perhaps it is rather early in the day to give so positive an opinion as some express upon this subject. Women have not yet had a fair chance to show what they can or cannot do in a profession from which, until the present generation, they have been excluded. Adverse views were held by male practitioners in law and medicine when it was first proposed to admit women to the practice of these professions, yet women have passed excellent graduating examinations in both, and some have risen to eminence in them. There is, therefore, pretty good ground for believing that, once admitted, they will make their way in architecture, particularly in some branches of the art. Of this innovation it is said editorially that "if nothing else," it "seems to indicate a change in sentiment as to the propriety of the sex entering on such callings as well as her ability to do so. What has already been accomplished by women in art and in many branches of the arts of design indicate an ability to cope with architectural design with the same readiness as her brother, and in the draughting room there can be little doubt that she will prove an average equal. In fact, for this class of work, she has every requisite for success. Her taste will more than average with man's; her perception is keen, and with that intuitive knowledge and quickness of expression which is her characteristic in every-day life, she is likely to prove a formidable rival to her

slower-growing and less keen-witted brother in some branches of architectural work."

But it it also urged that the instincts of women will inevitably direct them to "specialties in any such profession as architecture and that no woman is likely to be long the director of the constructive work of a building. She would soon conclude her sphere of usefulness lay in other directions. Not that she could not as fully comprehend and direct as a man, but she would soon tire of its disagreeable features." In this most people will probably agree with this very temperate, fair and unprejudiced view of the subject. It is hoped that women may have their chance in architecture, and opportunities to make the most of it.

American Theaters.

THE literature of theater construction and design has not recently lacked contributions. Both in American and English publications the subject has received, and is now receiving, an unusual amount of attention. For the most part, it has been treated in serial papers, and most of the important theaters and opera houses in the large cities of the world have been illustrated with exterior and interior views, or will have been, when a series of papers entitled "The Planning and Construction of American Theaters," commenced in *Architecture and Building* in its issue of October 13, and written by Mr. Wm. H. Birkmire, shall be completed.

A commencement is made with a description of what is probably the largest building in the world devoted wholly to popular amusement, Madison Square Garden, occupying the entire city block bounded by Fourth avenue, 26th street, Madison avenue (on which is the main entrance) and Twenty-seventh street, in New York city. An excellent illustration of this building (which, though only completed last year, is becoming famous not only for its great size but for the beauty of its architecture) is given, and it is to be regretted that the brief description of the building could not have been aided by interior views, which, however, are wanting. As it is, while the beauty of the exterior and the great size of the structure are well indicated, a very imperfect conception of the interior can be gained.

A description is given of the Metropolitan Opera House, New York, which having been seriously injured by fire has been recently remodeled. Neither exterior or interior views of this theater are supplied. The lighting of the great building requires 10,000 electric lamps, and nearly half of this number are on the stage. With the description of the famous Chicago Auditorium, two interior views are given. It is evident, from all the descriptions that brevity has been studied. The stage of the Auditorium has some special features.

"The dimensions of the stage are 70 by 110 feet. The height from the floor to the rigging loft is 95 feet. The stage floor is divided into sections, all of which are separately or jointly movable in the vertical plane. This movement is effected by twenty hydraulic jacks, the plungers of which range from 6 to 24 inches in diameter and which are operated under a pressure of 100 pounds per square inch. The valves controlling these jacks are concentrated in such a manner that a person operating them is always in a communication with and under control of the stage manager. It is possible with this apparatus to create variations and gradations of level of stage floor almost instantaneously in any direction, up or down or oblique, for any part of the stage floor. This hydraulic apparatus is modeled upon that patented by the 'Asphalia' of Vienna, and applied by it in the opera house of Buda-Pesth, Prague and Halle. The ingenuity of American builders of hydraulic elevators and the special conditions prevailing in this building have, however, caused the introduction of many improvements and modifications of the European apparatus.

Yet the main room in this building is too large for any successful dramatic presentation. The actors cannot be well heard in so large a room. Operas and concerts may be well rendered in it.

After this brief trip to Chicago a return

to New York is made, and after brief mention of the Empire Theater follows a partial description of the Abbey Theater, but which, more elaborate than the previous ones, and is to be continued. While not very comprehensive, these descriptions, so far as they go, will serve to give fairly good general ideas of most of the theaters selected as subjects.

Dwellings for the Poor in Edinburgh.

MORE light upon the subject of city dwellings which can be let at low rentals, may be derived from an abstract of a report of a sub-committee of the Lord Provost's committee of the Edinburgh Town Council, which deals with the subject of dwellings for the poor, and which is printed under the above title in the *Architect* (London). The idea is to build one block of 56 houses, if such buildings ought to be called houses, 24 of one room, and 32 of two rooms each. The lowest rentals in the city are $50 a year. In the words of the committee, "Edinburgh suffers severely from want of sanitary and healthy housing for its poor and laboring classes." From which it may be inferred that there are many poor families in this famous old Scotch city whose wage earnings will not permit them to pay as high as $50 per year rent for their homes.

"It is sometimes argued that this matter may be left to private enterprise, but the sub-committee are unable to detect any likelihood of private enterprise doing anything in the matter. Past experience proves that private enterprise will not be by any means forward in taking up this question. Private philanthropy has done more perhaps for Edinburgh than any other city in the kingdom, but no such agency, other than the Social Union, has as yet come to the front. The sub-committee is convinced, after a careful consideration of all the circumstances of the case that the public authorities themselves must face this question in a practical way; and they further consider that, if properly conceived and carried out, with the aid of the facilities provided in favorable borrowing powers, such an undertaking may be financially self-supporting, besides resulting in social and moral benefit to the inhabitants of the districts in question, and therefore to the whole city."

It is asserted that in this experiment the best features of modern improved housing for the laboring classes will be adopted, that is to say, the scheme will aim at providing . . . . houses which will to a large extent combine advantages of home privacy, the convenience and supervision of a modern lodging house with all modern sanitary appliances, a recreation hall, a creche, children's grounds and other advantages. In order that the rentals shall pay a moderate interest on the investment, the rentals will be for each of the 1-room apartments £5 4s., and for the 2-room apartments £7 6s. per annum.

This seems to indicate a belief, surely not warranted by the previous history of similar attempts, that the erection of such tenements will abolish slum life in Edinburgh, which of course depends more or less upon what is meant by slum life. A very large part of the slum life in New York city is to be found in tenement houses very like what are to be built in Edinburgh, barring the recreation hall the creche, children's grounds, etc., which would admittedly be an advance upon ordinary tenement house conditions.

INDEX TO LEADING ARTICLES.

The journals quoted are indicated by initials, and their full titles are given in the opening pages of the Review. Other abbreviations are, Ill=Illustrated; W=Words.

*25759. Historical Architecture in Current Use.—A Striking Arraignment of Present Methods. William Henry Goodyear (E Mag-Dec.) 4500 w.

25797. Old and New Buildings of New York. Ill. (Sc A-Oct. 13.) 500 w.

*25861. Whitby Abbey (B-Oct. 6.) 1800 w.

*25809. Fireproofing City Houses. C. H. Blackall (B B-Sept.) 1400 w.

*25894. Machinery for Building (I C B-Oct. 5.) 1600 w.

*25976. A Temple of the Tokugawa at Nikko. Ill. C. T. Matthews (A R-Oct.-Dec.) 4500 w.

We supply copies of these articles. See introductory.

*25905. Frieze and Cornice. W. N. B. (Pl D-Oct.) 1200 w.

*25977. Influence of the French School on Architecture in the United States. Ill. Ernest Flagg (A R-Oct.-Dec.) 4200 w.

*25978. The University of Chicago. Ill. Charles E. Jenkins (A R-Oct.-Dec.) 1600 w.

*25979. Architectural Aberrations.—College of St. Francis Xavier (A R-Oct.-Dec.) 1500 w.

25988. Acoustic Properties and Resonance of Buildings (Sc A-Oct. 20.) 1000 w.

26041. Woman in Architecture. Editorial (A & B-Oct. 6.) 900 w.

*26098. Dwellings for the Poor in Edinburgh (A L-Oct. 5.) 1400 w.

*26099. The Housing of the Working Classes; Sanitary Powers Relating Thereto in Liverpool. (Abstract.) W. Goldstraw (A L-Oct. 5.) 3200 w.

26123. Report of the Committee on Education to the American Institute of Architects. Henry Van Brunt, Chairman (A A-Oct. 20.) 2800 w.

26124. Skeleton Construction and the Fire Department. T. M. Clark (A A-Oct. 20.) 2000 w.

*26136. Foundations in Deep and Unreliable Soils. Address of Charles Baillairgé (Can A-Oct.) 4000 w.

*26137. Notes on Some Aspects of the City of the Future. A. T. Taylor (Can A-Oct.) 1700 w.

*26144. The External Color Decoration of Buildings. Cesare T. G. Formilli (A L-Oct. 12.) 2700 w.

*26217. Progress of the Wembley Tower. Ill. (I & I-Oct. 19.) 1500 w.

†26230. Notes on the Hardening of Mortar. William P. Mason (J A C S-Nov.) 400 w.

*26243. Regulations for the Preservation of Ancient Buildings in Italy. Translated by John Hebb (A L-Oct. 19.) 1600 w.

*26244. Discoveries in Architecture. T. Roger Smith (A L-Oct. 19) 5500 w.

*26245. The Style Hunters. J. W. Yost (A L-Oct. 19.) 1800 w.

*26283. The History of Architecture. Ill. J. Edwin Forbes (I C B-Oct. 19.) 7000 w.

26300. Italian Villas.—From N. Y. Tribune (A A-Oct. 27.) 2000 w.

†26330. The Churches of Provence. Ill. Mrs. Schuyler Van Rensselaer (C M-Nov.) 10000 w.

*26362. On the Use of Brick in Ecclesiastical Architecture. Ralph Adams Cram (B B-Oct.) 2200 w.

*26447. Tiles. (I C B-Oct. 26.) 1200 w.

26477. The Wholesale Architect as an Educator. C. H. Blackall (A A-Nov. 3.) 2000 w.

*26485. Workmen's Dwellings in Manchester and Salford (B A-Oct. 26.) 2500 w.

*26542. Greek Sculpture in Relief (A L-Oct. 26.) 3700 w.

26589. Reasons and Remedies for Rust in Skeleton Structures. Clement D. Rinald (A & B-Nov. 10.) 2800 w.

26610. Concrete Construction.—Its Practical Application. Ernest L. Ransome (Sc A S-Nov. 10.) 4800 w.

26623—75 cts.. The Selection of Sites for Federal Buildings. Glenn Brown (A Rev-Vol. III, No. 4.) 2000 w.

26624.—75 cts. Architectural Education for America. Albert L. Brockway (A Rev-Vol. III, No. 4.) 3600 w.

Serials.

12568. Building Construction and Superintendence. Ill. F. E. Kidder (A & B-Began May 6, 1893—35 parts to date—15 cts. each).

18857. Electrical Science for Architects. Russell Robb (A A-Began Jan. 13—7 parts to date—15 cts. each).

19078. Problems in Stone-Cutting. Ill. Ed. W. Hind (S-Began Jan.—8 parts to date—30 cts. each).

19713. Brick and Marble in the Middle Ages. Ill. (B B-Began Jan.—10 parts to date—30 cts. each).

20419—Modern Methods of House Painting. A. Ashmun Kelly (Pl D-Began March—8 parts to date—30 cts. each).

21288. Theatres. Ill. (A A-Began April 14—7 parts to date—15 cts. each).

21618. Bay Windows and Oriels. Ill. F. Jerman (I C B-Began April 20—11 parts to date—30 cts. each).

21736. The Art of Building Among the Romans. Ill. Auguste Choisy. Translated by Arthur J. Dillon (B B-Began April—6 parts to date—30 cts. each).

22717. Terra Cotta in Skeleton Construction. D. Everett Waid (B B-Began May—3 parts to date—30 cts. each).

24273. Arkansas Marbles. T. C. Hopkins (S-Began Aug.—3 parts to date—30 cts. each).

25577. The Influence of the Hanseatic League on the Architecture of Northern Europe. Ill. J. Tavenor Perry (A A-Began Sept. 29—3 parts to date—15 cts. each).

25843. The Pernicious Practice in Selecting Competitive Plans (S A-Began Oct.—1 part to date—30 cts).

26069. Modern Steel Fireproof Construction. F. M. Small (A & B-Began Oct. 13—1 part to date—15 cts).

26070. The Planning and Construction of American Theatres. Ill. William H. Birkmire (A & B-Began Oct. 13—1 part to date—15 cts).

26135. Artificial Foliage in Architecture. Ill. Hugh Stannus (J S A-Began Oct. 12—3 parts to date—30 cts. each).

26202. Theatre Fire Catastrophes and Their Prevention. Ill. William Paul Gerhard (Sc A S-Began Oct. 27—2 parts to date—15 cts. each).

CIVIL ENGINEERING

For additional Civil Engineering, see "Railroading" and "Municipal Engineering."

Construction of Irrigation Canals.

As an aid to "irrigation engineers who are only beginning their experience in that line," Mr. H. P. Bell has contributed to the *Annual of the American Society of Irrigation Engineers* for 1892–93, issued in October, a paper entitled "Random notes on the survey and construction of Irrigation Canals," which is an important contribution to the literature of irrigation. At the outset he confesses that there was a time when these notes would have been of good service to him, and hopes they may be of similar service to others.

Upon the subject of surveys many useful hints are given. "The first operation is to begin at the selected head and take a series of long sight levels down the course of the river to ascertain its approximate fall." A case is cited (of a large river) where the result of this necessary work proved that no canal was possible within the limits of the district to be benefited, the fall being insufficient. Suppose the fall is to be within limits of practicability. "It is seldom necessary to go further than a certain distance to obtain the necessary information. Perhaps one-fourth to one-half the length of the projected canal. These levels should be taken with two rods to save time, the engineer making a sketch and estimating roughly his distance at the same time."

The survey, after the engineer has gone down the river far enough to satisfactorily determine its fall, is to be extended "hillwards across the valley until he records the elevation assumed as the head of the works," and until he is able to "fix the location of any chosen grade upon the line of his cross levels according to his estimated distance, and is therefore also in position to estimate approximately the rate of his grade."

Next a turn at right angles from the "hillwards" line of survey is advised and a leveling down the valley "more or less upon the line of the canal, still guessing the distance, and going up or down if he thinks it worth while, or necessary to rectify position from time to time, according to the distance estimated and the grade assumed.

A method used by "the select few" but which is alleged to be simpler than the prevailing method is noted.

"An expert engineer and two good rodmen (they may be laborers) will find no difficulty on moderately even ground in making good more distance throughout the day than he will care about covering again if he has to walk home at night. Having gone as far as it is intended to build the canal he should turn at right angles across the valley back to the river and take his last line of levels.

"Throughout the operations described as many good bench marks should be established as possible for future reference. The taking of these levels being done, he should finish his track survey of the river bank up stream to the point at which his first line of cross levels originated.

"With the information so obtained in hand the engineer will be able to make a good sketch, and define approximately the area of the country to be considered, and also to proportion roughly the prism of the upper section of his canal at the headworks."

As a guide to the selection of sites for dams and their construction, M. P. J. Flynn's book on irrigation is strongly recommended. A caution is given against following railroad precedents, a practice likely to lead to error. "Not even that remarkable fungus, the railroad trestle should be used without comparison with other methods."

A scheme for estimating cost of a syphon aqueduct is presented.

In traversing "the instrument should be

clamped at zero on the true meridian and the variation turned off so as to make the needle read zero when the plates are set on the meridian. Each time the instrument is moved and directed to the last point the back reading should remain on the plates. As a consequence, after making the circuit of the polygon and returning to the initial line, if the reading be not the same as before, some error has been made. If the needle be always read it is almost impossible to make a numerical error. No deflection angle is entered in the notes; only the plate bearing. There is not even any necessity to observe whether the direction be right or left, as the protractor graduation will point that out correctly afterwards when the bearings are plotted radially, just as with compass work.

"In any section of country where there is not much magnetic attraction a polygonal traverse, made with a good compass, will close as well, if not better, than one made with a transit instrument. . . This statement based upon the experience of many surveys with both instruments, will be controverted by many engineers, who use only the transit, but by few who have used both.

"Many men use transits that are slightly out of adjustment without taking two points. A traverse made with such an instrument is morally certain to be inferior to one made with a good compass, even where some small amount of local attraction is found at intervals. When a transit is known to be out of adjustment, and is used without double pointing, the same side of the dial should not be used in the same direction twice in succession, but alternately. It is evidently better, however, to adjust it at once, even if it takes a little time.

"Having surveyed the line of canal to its termination as described; a levelled and chained cross section should be made from the end of the canal to the river, and the latter thence traversed up stream, stopping at intermediate points to take long cross sections of the valley back to the line of the canal, at such a distance apart as may be convenient to determine the profile and location of minor channels, *i. e.*, the distribution system. Finally the traverse line is closed at the head of the works where it was begun."

Timber used for trestles should be treated differently from the way it is commonly used upon railroads. "Any engineer who has been in the habit of examining railroad trestles and trusses in use for say three years, will have noticed that the larger the scantling the greater is the splitting and checking lengthwise, and therefore the greater the introduction of moisture that has no opportunity to dry out quickly. This is the case more particularly with timber put into work while green. Timber being a bad conductor of heat, the outer fibre under external influences shrinks much faster than the parts within, the result of this is to split the stick endwise because the inner portion not shrunk forces apart the fibers, reacting against the outer shrinking. This is a point that does not admit of much argument, because we know from actual levels that fourteen $12'' \times 12''$ sticks of Oregon pine or Douglas fir, built into a crib green, will go down 12 inches in seasoning."

It is concluded from these facts that composite or built-up members are more durable than solid sticks of timber. This important conclusion is illustrated by descriptions of the condition of different structures examined after they have been in use long enough to indicate relative durability. Other important points in practice are given, and the careful perusal of the paper is recommended to all young engineers intending to make irrigation a part of their future business.

An interesting Engineering Feat.

EARLY in 1893 it was decided to alter the grades of portions of the Myrtle Avenue Elevated Railway in Brooklyn, N. Y., and to do it if possible without interruption of traffic. An account of how this was done, entitled "The Myrtle Avenue Improvement on the Brooklyn Elevated Railroad," was given in a paper read at the American Society of Civil Engineers at its October meeting by O. F. Nichols, and is printed with illustrations in the *Railway Review* (Oct. 13).

To properly comprehend the nature of the difficulties to be surmounted it is necessary to understand that the road is an iron structure in the nature of a continuous bridge over the roadway of the street, upon which is a surface tramway doing a large traffic, and which at certain hours of the day is in some of its parts thronged with vehicles. The alterations were to be made without materially interfering either with the street traffic or the regular business of the elevated railway, some of whose grades, as first constructed, had been found too excessive. The superstructure of the road is supported by Phenix posts resting at the bottom upon brick piers. It was decided to shorten these posts at points where alterations were needed by cutting them to the proper lengths, instead of replacing them wholly by new posts; and in order that the work might proceed with sufficient celerity, it was also necessary that a considerable number of the posts should be operated upon simultaneously. The problem of safely supporting the superstructure for a considerable distance in such manner as not to interrupt the traffic either on the structure itself or on the street below, was solved as follows:

"The earlier plans proposed to cut a section out of each column a little above its base, splicing the two parts of the column together with plates riveted on the sides; this avoided the awkward cutting of columns, about 20 in number, on which the drop-end girders extended down the side of the column more than 2 feet; it also retained the rigid connections between columns and girders, which it then seemed wise to rely upon, in part at least, as a safeguard against an overturning tendency."

It was at first contemplated to cut the columns by a cold saw, but the cost of a machine for this purpose caused the project to be abandoned and they were cut by hand. "The columns were firmly fixed by rust joint into heavy cast iron bases about 3 feet square, and these were bolted to the brick masonry piers. It was finally decided to take advantage of the columns themselves to steady the lowering apparatus, and to cut the columns off at the top. Yellow pine timber for lowering was used. All of the vertical sticks were suspended from transverse girders; this avoided all handling of these timbers during the progress of the work. The larger vertical timbers were secured to the girders by built T irons, bolted to the sticks and to the girders to aid in preventing tilting of the girders. Two channel irons held together by four bolts, formed clamps placed near top and bottom of columns to steady the timbers; the middle bolts served as separators, and the end bolts as guides. A space was left between the back of column and the corresponding bolt, to allow the column to spring out $\frac{5}{8}$ inch at the top when the girder was lowered into the back channel of the column; this space was filled by wooden wedges at other times.

"Two 60 ton hydraulic jacks were used, one under each of the smaller sticks at each end of the girder. When the larger timbers were placed in position they were left 12 inches short of reaching the main blocking. This space was filled by three carefully dressed blocks 4 inches thick, 14 inches wide and 3 feet long, bolted through edgeways to prevent splitting.

"The brackets were cut between columns and girders, the blocking and vertical timbers were carefully placed, and lock wedges driven under the large timbers to give a firm and uniform support. The side plates and angles forming caps of the columns were then removed and placed in correct position for new caps, the rivet holes having been previously drilled. The horizontal seat plates were cut out to fill the back channel which was to be left intact; the edges of the vertical angles at ends of girders were also cut out to make sure of their entering the channel freely.

"When the sides of the column cap were secured in new position the inside channel of the column was cut off with a heavy diamond point tool held by one man while another struck it with a heavy hammer; the diamond point tool was made of 1 $\frac{1}{4}$ inch, octagon steel, about 2 feet long. Two men would frequently cut a channel off in two hours; the surface of

the cut was afterwards dressed up with a hand chisel and hammer. As soon as the new column cap was completed by adding to its top plate, blocks $6'' \times 6'' \times 18''$ were piled on it in pairs and wedged under the end of the girder, to give additional support.

"The cutting of the columns was started at the summit of the grade where it amounted to 5 feet 7¼ inches. When the columns of three bents had been cut, the girders of these bents were at once lowered 4 inches; the columns were sprung out by slacking the wedges at the back clamp bolt and driving other wedges between the column and the heavy timber; and the girders at once entered the channels, which, from this on, formed guides to steady and keep them in place. The cutting was extended until the girders at the summit could be lowered 12 inches. The lowering was done by two gangs of six men each, one on each side street at each of the columns; the superintendent with one gang and the assistant with the other. Two men handled the jack, two the blocking, and the other two adjusted the clamps, which were never allowed to get too slack or drop out of position.

"The jacks had 12 inches left, and had let-off cocks by which the lowering could be checked at any point by the slight movement of a key in the hand of the foreman of the jack. In lowering the jacks were set up to relieve the 4-inch block; this was then backed out, followed by a block 1 inch thinner, and this in turn backed out, followed out by a thinner one in the same manner. In case of accident to the jack the vertical timber could not, therefore, drop more than 1 inch.

"When each girder had been lowered the first 12 inches, it became necessary, if it was to go lower, to saw off the heavy vertical timbers. The girders were then blocked directly on the iron column, the jacks slacked, and the timber sawed off 16 inches. A lowering of 4 inches again brought the blocking to the standard of 12 inches.

"The first blocking was placed on June 1, 1893. The lowering was completed on July 1, 1893. The greatest weight obtainable on any column from structure and trains was 156,000 pounds."

This was truly a very interesting example of engineering work which had few if any precedents, and which required skill, care and forethought for its successful accomplishment. An account of the method of removing the stations, and a statement intended to show that the changes were profitable to the road are added.

Use of Ice Boring Machines for River Surveys.

IN the government improvement of the navigation of St. Mary's river, a method of cutting holes through ice by means of an ice auger, instead of by the use of axes and chisels, was found to be an economical innovation. Mr. Joseph Ripley in *Proceedings of the Michigan Engineering Society* (*1894*) describes the method, and the reasons for its adoption. As soundings through ice are frequently one of the most convenient methods of ascertaining the depths of river channels, and as the method of cutting holes through the ice on the St. Mary's saves a great deal of useless labor, *Engineering News* has reprinted Mr. Ripley's paper.

"Having adopted the method of bank measurements in place, as being the most accurate one for determining the amount of material removed above specified grade planes, it was necessary to make detailed surveys of all the shoals. These were generally made in the summer time, but nearly every winter since 1870 soundings have been taken through the ice on the canal or river at places where it was necessary to check the amount of the season's work as estimated from the scow loads, or where it was difficult to sound from boats or rafts on account of the rapids or the frequent passing of steamboats."

At first cavities were chopped in the ice with woodman's axes to as great a depth as the nature of the implement permitted, and then the holes were cut through with an ice chisel. A local machinist, seeing the labor involved in cutting the holes undertook to make an ice auger that would bore 3" holes. He succeeded in making one that enabled two men to

do with it as much as three could with axes and chisels. Improvements made by Mr. Ripley have increased the efficiency of the machine, until two men are now able to do with it the work of twelve with axes and chisels.

"The auger is made by bending a bar of ¾" square steel in a spiral around a bar of 1½" round iron. The best distance for lead of spiral is 2½". The lower end is drawn into a chisel edge, which is widened to $1\frac{9}{16}$" so as to clear both the inside and the outside of the spiral. Great care has to be taken in sharpening the auger, as one stroke of the file will change the edge so as to make it quick or slow cutting.

"The auger is fastened to the shaft by means of a thread and jam nut on its shank. The shaft is made in sections of 5 feet 1¾ inches round iron. A keyway slot ⅜ inches wide and 3-16 inches deep is cut the length of the shaft. The revolving motion is transmitted to the auger by turning a crank fastened on the shaft of the driver of the bevel gearing; connections being made by means of a lug in the bore of the bevel pinion traveling in the groove of the shaft as it moves up and down.

"An iron tripod 7 feet high is placed on the frame. A line fastened to the swivel on top of shaft and passing through a block hung from top of the tripod is used to raise the auger the instant it cuts through the ice, and holds it up by passing a knot in the line into a U cleat. By holding taut on the line the auger is kept from binding when changing from snow ice to clear blue ice."

The effect of cold on the strength of cast-iron is indicated by the fact that some of the gear teeth broke out in extreme weather when the temperature fell to —30° F.

With a party consisting of "a chief, 2 men for sounding, 6 men to operate three boring machines, 2 men to move tag-lines and mark places where holes are to be bored, 2 or 3 men to shovel snow after the holes are bored, so that the sounders can see the water surface, 1 water-gage observer and 1 cook, Mr. Ripley estimates that 3000 holes can be made in eight hours," and that "the cost would be about $1000 per month." The location of soundings can be made through the ice far more accurately, and the work done cheaper than from boats in the summer.

The Canadian Sault Ste. Marie Canal.

THE near approach to completion of this great work has called forth an interesting editorial in the *Iron Age*, which gives in brief a statement of the commerce of the canal for the last five years. The work is spoken of as "the pride of the Canadians," and as "the last link in a chain of waterways that has cost the debt-burdened Dominion over $67,000,000, and which will at no distant day allow ocean vessels passage to the northern lakes." It is, however, clear that this does not mean such passage immediately, on account of other yet incompleted links on the lower St. Lawrence, "where from reasons best known to itself and the mother country the Dominion is now replacing a canal on the south side of the river by another a little further away from the United States and on the north side."

The changes in the plan, of which there have been three since the work commenced, "to suit the growing commerce of the lakes"; show that only a very partial idea of the probable future of this commerce was entertained by any one at the time the work was projected.

"This new canal is a prodigious undertaking for a country burdened with an enormous debt and of little internal commerce—only 5 per cent. of the last year's commerce of the Sault was in Canadian vessels—for the work has cost over $4,000,000. It has, however, been rapidly pushed, and though begun two years after the new United States canal at the same place, it is completed a year and a half before the date set for the opening of the other. The work has been done as an imperial, and not as a commercial necessity. It is to render the Dominion and its transcontinental highway independent of the United States, and the two events that marked, first its beginning and second, an effort to push it by extra inducements offered its

contractors, were the refusal of the United States government to allow the transportation of Canadian soldiers through the American canal in 1885, and the retaliatory measures adopted by Congress in 1891."

"So much has been said of the commerce of the Sault Ste. Marie that it may be unnecessary to say that for the past five years this waterway has exceeded the Suez, and that in 1893, while the Suez passed 3341 vessels, bearing a tonnage of 7,650,000 tons, the American canal, though open only seven months in the year, passed 12,800 vessels and 10,796,000 tons of freight, valued at $145,500,000. The present American canal is so inadequate to handle the traffic that now vessels are often compelled to wait nearly the whole of the 24 hours to get an opportunity to pass; so that the new canal is needed at once. In 1890, while digging for a small water power canal on the Canadian side, workmen came on the remains of a canal built away back in 1796, which had been destroyed by United States soldiers in 1812, and has been forgotten ever since. The first large canal was built in 1855 by the state of Michigan and was afterward turned over to the general government. The entire business of the first two years of this canal is often exceeded in a single day, and the business of the present year to date is more than that of the first ten years of its history.

"But while the Canadians look with pride on this work as bringing to a magnificent conclusion their long and cherished plans, those who know the facts are despondent that there could be built such a work at such cost and under the supervision of the government, and that it should be so defective and so in need, even before its completion, of costly and immediate repairs. These defects are glaring."

Some of the walls are already bulging, some parts of them have been already rebuilt. Bracing and patching have been done in other parts, and a cause assigned for this is the "placing under the massive masonry walls of timber crib work which is unable to hold the weight of the stone."

It is added that this was done when the canal was deepened, and that the water was let into the canal sooner than it would have been, partly to hide this and other defects. In other respects the quality of the work is severely criticised.

The Panama Canal.

AN editorial abstract in *The Engineer* (London, October 5) states that a new company having been formed for taking over the works on the Panama canal, it "has issued a report, giving what professes to be an accurate idea of the present state of the canal." The guarded form of this expression indicates a suspicion that the report has been tinged with *couleur de rose*, and the character of the report certainly lends force to such a suspicion. The well-known rapidity with which neglected machinery and implements deteriorate in moist tropical climates, and the impulsive manner of the Chagres river in the matter of its periodical floods, would incline one to expect that after five years' interruption of the work everything would be found in a state of most discouraging dilapidation. The report, on the contrary, represents that "the canal itself has remained practically intact, and the machinery and other plant has only partly deteriorated from the climate." "Partly" is a word of such elasticity that it can stretch all the way from the slightest injury to any point short of total destruction.

An attempt is made to explain away adverse statements on the part of those who have visited the works, by the fact that vegetation is very luxuriant at Panama, that its growth has obscured the real condition of affairs, and that when this has been cleared away, everything will be found in much better condition than it appears to be from superficial examination. It is moreover urged "that so far from being a disadvantage, this growth has actually been of service in preserving the canal, and the vegetation can be cleared away at very little cost.

"After the maritime reach, which terminates at 22,500 kilometers, are the works of the first lock, and these are in an excellent state of preservation. From this

point the cutting continues with an embankment 50 meters in height, but notwithstanding the steepness of the sides not a stone has given way; and this is set down to the protection afforded by the dense vegetation. This state of things is unchanged across the plain of Tavernilla as far as kilom. 36; at this point the excavation runs close to the river, from which the water descends during the rainy season. This is particularly noticeable between kiloms. 25 and 28, and between kiloms. 33 and 34. In the middle of the plain of Tavernilla are the large cunettes which, notwithstanding their steep incline, have in no way been affected by the severe floods of four years ago. The works facing San Pablo are also unchanged, though entirely covered with vegetation."

Between the 34th and 40th kilometers the filling up has been rapid. At Matachin, the point for the third lock, the works are in a good state of preservation. At the 46th kilometer "the works for the fourth lock are in good order. . . . A little more than a kilometer further on the banking fell in during the work of cutting."

Similar favorable accounts are given of the condition of affairs over most of the entire length where work has been done; and of the sixteen 120 horse-power dredgers and other machinery ten dredgers are said to be as good as new, six will need extensive repairs, and the rolling stock is not in such poor condition as might be expected. The railways are, however, completely useless until relaid with new ties, the latter being completely rotted away.

The ends sought by the company are considered an enigma by *The Engineer*.

INDEX TO LEADING ARTICLES.

The journals quoted are indicated by initials, and their full titles are given in the opening pages of the Review. Other abbreviations are, Ill=Illustrated; W=Words.

Bridges.

26103. William A. McGonagle's Paper on Bridges (R A–Oct. 19.) 1800 w.

26192. The Saginaw Bridge Failure. Ill. (E N–Oct. 25.) 800 w.

*26220. New Victoria Bridge over the Brisbane River. Ill. (Eng L–Oct. 19.) 2000 w.

26309. Concrete Bridge at Munderkingen. Ill. Translated by K. Liebbrand (R R–Oct. 27.) 1500 w.

*26427. Modern Spanish Bridge Engineering. Ill. W. Lodia (P–Nov.) 1000 w.

*26513. Pivoted Arched Bridges (Eng L–Oct. 26.) 2700 w

26563. A Great Structure.—Something about Cabin John Bridge on the Line of the Washington Aqueduct. Ill. (I Age–Nov.) 1000 w.

26621. Cheap and Serviceable Bridges (M R–Nov. 9.) 700 w.

26634. Certain Changes in the Victoria Bridge. Ill. (R G–Nov. 9.) 700 w.

Canals, Rivers and Harbors.

25840. Use of Ice-Boring Machines for River Surveys. Ill. Joseph Ripley (E N–Oct. 11.) 1400 w.

25841. Canal of the Water Supply and Storage Company of Fort Collins, Col. Ill. F. T. Lewis (E N–Oct. 11.) 600 w.

25849. The North Sea and Baltic Canal (R G–Oct. 12.) 1200 w.

*25856. A Few Points about Dredging (Tr–Oct. 5.) 1700 w.

*25932. The Works at the Panama Canal (Eng L–Oct. 5.) 1300 w.

25944. Effect of Drainage Canal on Level of Lakes (M R C–Oct. 11.) 900 w.

25989. The Great Chicago Canal. Ill. (Sc A–Oct. 20.) 1800 w.

*26043. Canalization of Rivers. Editorial (Eng L–Oct. 12.) 2100 w.

*26148. Ultimate Results of the Chicago Drainage Channel. Ill. G. P. Brown (D E–Oct.) 1800 w.

26168. The Canadian Sault Ste. Marie Canal. (Ir Age–Oct. 25.) 900 w.

26397. The Proposed Lake Superior and Mississippi River Ship Canal. Ill. (E N–Nov. 1.) 800 w.

*26444. The Manchester Ship Canal.—The Cost and Difficulties of Its Construction. Ill. E. Leader Williams (E Rev–Oct. 20.) 1200 w.

*26547. German Waterways and Water Carriage (Tr–Oct. 26.) 800 w.

26591. The Great Chicago Canal (B J C–Nov. 10.) 1700 w.

26632. The Baltimore Ship Canal Project (R G–Nov. 9.) 1200 w.

26655.—$1.50. Hoisting Apparatus of the Canal Head-Gates at Sewall's Falls, N. H. Ill. John R. Freeman, with Discussion (T C E–Sept.) 13500.

Hydraulics.

26191. The Drainage of the Zuyder Zee (E N–Oct.) 25.) 1500 w.

*26336. Pumps (A M S–Sept. 22.) 2200 w.

26356. "Back-woods" Hydraulic Engineering. James F. Hobart (A M–Nov. 1.) 3000 w.

We supply copies of these articles. See introductory.

26411. The Flow of Water and Gases Through Long Pipes. G. D. Hiscox (Met W-Nov. 3.) 1600 w.

26480. Water Wheels. Ill. H. L. Aldrich (Pr-Nov.) 3500 w.

26630. A Great Water Power Development Enterprise at Ogden, Utah. W. P. Hardesty (E N-Nov. 8.) 3800 w.

Irrigation.

†26071. Pipe Irrigation. — Wooden Stave Pipe. Ill. S. Fortier, with Discussion (A S I E-1892-93.) 4800 w.

†26072. Continuously Riveted Steel Water Pipe. W. C. Parmeley (A S I E-1892-93.) 2000 w.

†26073. A Reservoir at Santa Fé, New Mexico. Ill. Edward F. Hobart, with Discussion (A S I E-1892-93.) 1800 w.

†26075. The Disposal of the Sewage of Trinidad, Colorado, by Irrigation (A S I E-1892-93.) 900 w.

†26076. Topographic Methods. Ill. Part I. Arthur P. Davis. Part II. Joseph B. Lippincott (A S I E-1892-93.) 3500 w.

†26077. Random Notes on the Survey and Construction of Irrigation Canals. Ill. H. P. Bell (A S I E-1892-93.) 3200 w.

†26078. Expensive Economy.—Errors in Irrigation Schemes. P. M. Narboe (A S I E-1892-93.) 600 w.

†26079. The Operation of Irrigation Canals. Edgar E. Clark (A S I E-1892-93.) 900 w.

†26080. The Necessity in the Engineering Profession for Closer Organization for the Purpose of Mutual Benefit and Support. J. C. Ulrich (A S I E-1892-93.) 4200 w.

†26081. Irrigation in California. W. G. Curtis (A S I E-1892-93.) 1200 w.

†26082. Irrigation Canals in the Caucasus. M. N. Gherceranof (A S I E-1892-93.) 3000 w.

†26083. The Development of Water Supplies for Irrigation Purposes. F. C. Finkle (A S I E-1892-93.) 2400 w.

*26084. The Rio Grande. F. H. Newell (A S I E-1892-93.) 1500 w.

†26085. The Forestry Problem of the Arid Regions. Arthur DeWint Foote (A S I E-1892-93.) 1500 w.

†26086. State Irrigation, Legislation and the Relation of Engineers and Experts Thereto. Richard F. Hinton (A S I E-1892-93.) 1700 w.

†26087. Concerning Rights in the Water of the Natural Streams of Colorado. F. S. Greene, with Discussion (A S I E-1892-93.) 6500 w.

†26088. A Bill for the Cession of the Arid Lands. A. D. Foote, with Discussion (A S I E-1892-93.) 6000 w.

†26089. Sand Gates in Canals.—A Discussion, Opened by J. S. Titcomb. Ill. (A S I E-1892-93.) 1800 w.

†26090. Discussion on Flumes and Fluming. Ill. Opened by J. C. Ulrich (A S I E-1892-93.) 10500 w.

26372. Irrigated Farm Lands in the Fertile San Luis Valley, Colorado. Ill. (W A-Oct.) 1000 w.

26373. Mexico and Irrigation. Ramon de Ybarrola (W A-Oct.) 2400 w.

26374. Irrigation Engineering. Herbert M. Wilson (W A-Oct.) 2500 w.

*26430. A Practical Illustration of the Duty of Water. Ill. (Mill-Oct.) 1400 w.

Miscellany.

*25788. The Institution of Civil Engineers' Suggestive List of Subjects for Papers for the Year 1894-5 (M W-Oct. 5.) 1000 w.

25844. The Archer Avenue Subway, Chicago, Ill. Ill. (E N-Oct. 11.) 900 w.

25847. A New Method of Determining the Character of Stress. Benjamin F. La Rul (E N-Oct. 11.) 800 w.

*26032. The West Chicago Street Railroad Tunnel, under the Chicago River, near Van Buren Street. Ill. Charles V. Weston (J A E S-Sept.) 7000 w.

26115. The Myrtle Avenue Improvement on the Brooklyn Elevated Railroad. (Abstract.) O. F. Nichols (R R-Oct. 13.) 1900 w.

26189. The Masonry Lining for the Mullan Tunnel, Northern Pacific Railway. Ill. (F N-Oct. 25.) 900 w.

26190. The Brooklyn Bridge, Cleveland, O. Ill. (E N-Oct. 25.) 750 w.

26198. The New Harlem River Speedway, New York. Ill. (ScA-Oct. 27.) 750 w.

26260.—$1. Notes on Certain Field Methods Used on the Survey of the Mexican Boundary in 1892-93. John F. Hayford (A E C U-1894.) 8200 w.

26629. A Rational Theory for the Strains in Columns. A. M. D'Armit (E N-Nov. 8.) 900 w.

26652.—$1 50. Removal of Rock 40 ft. Below Surface of Water, North River, N. Y. Ill. John A. Bensel, with Discussion (T C E-Sept.) 6500 w.

Serials.

22758. The Chicago Drainage Canal. Ill. R R-Began June 9—Ended Oct. 6—16 parts—15 cts. each).

24732. Good Mortars. R. N. Buell (B B-Began Aug.—2 parts to date—30 cts. each).

25445. Clyde Truss Dredging Plant. Ill. (E-Began Sept. 21—Ended Oct. 5—2 parts—30 cts. each).

25521. The Waterway from Chicago to the Gulf. Ill. (Mill-Began Sept.—2 parts to date—30 cts. each).

25661. Module Gate. R. G. Kennedy (I E-Began Sept. 1—3 parts to date—45 cts. each).

25858. The North River Bridge.—Appendices (E R-Began Oct. 13—4 parts to date—15 cts. each).

26048. West India Dock Improvement Works. Ill. (E-Began Oct. 12—2 parts to date—30 cts. each).

DOMESTIC ENGINEERING

Good and Bad Plumbing.

"If there is that facility afforded by poor plumbing for the entrance of disease to residences that there is claimed to be, then proper plumbing becomes one of the most important of the builders' arts." This is the opening sentence of a good editorial in *The National Builder* (Oct. 13). The recent discussions in the Sanitary Congress at Liverpool have had the effect of arousing public interest in this important subject to an extent hardly equalled by previous discussions. There are yet those who have small faith in the declarations repeatedly made, that diseases frequently enter households through avenues not obstructed by good plumbing.

What is good plumbing? It is not difficult to frame a brief answer to this question in general terms. To specify them in detail would make the answer long. Good plumbing is a system of durable and convenient receptacles, pipes and appliances which permits free flow outward from a dwelling of its drainage, and absolutely prevents inward flow of anything, be it even the most subtle gas or minutest conceivable microbe. An answer is given to those who still doubt. It is an answer also to some who, even if admitting that disease occasionally gains access to dwellings in this way, yet believe such cases are so rare as not to call for special refinement in plumbers' work.

"That bad plumbing is responsible for many diseases which are called contagious there can be no reasonable doubt. It has been investigated too often and too long to permit of any doubt now. If we were allowed a doubt upon this matter now, one would be given the right to doubt any announcement of fact which science has made, and the whole course of scientific investigation could be thrown aside as worthless and misleading.

"There are others who, while they do not dispute that poorly constructed plumbing may become the direct means of communicating these diseases, claim that where bad plumbing exists there will be found every condition necessary for the development of these disease germs should they fall in or about the household. They admit that with bad plumbing these germs of disease have opened up to them avenues by which they may enter rooms much more readily than where the plumbing is good. When they have once entered they find every condition necessary for their growth."

This puts the whole case in very brief yet comprehensive form. Whether diseases enter by routes left insufficiently obstructed or not, when they do enter, bad plumbing affords a nidus for their propagation. "Defective plumbing is in the nature of things intolerable and bad. It does not take a physician to tell us this. Leaky joints, defective pipes, badly set fixtures and the like will, in time, make our houses cesspools, hidden, perhaps, but their pollution will finds its way to our families and take the vigor and vitality from them. If they breed no special disease, the filth and contamination caused by them will vitiate the health, weaken the step, and destroy the suppleness of youth ere the period of manhood or womanhood is reached."

Sanitary plumbing is not a term cunningly devised as a pretext for getting better prices for work, though it has been sometimes made such a pretext by unscrupulous men. Plumbers' trade organizations will, in time, weed out those who are unscrupulous, or incompetent. This is, or ought to be, an object of every trade organization worthy of the name and of the trade it represents, and the effort to effect this is an encouraging feature of modern industry.

Radiator Condensation.

IT is well known that the amount of water condensed in a steam radiator in a given time can be made the measure of its heating capacity. More than this, it is the most reliable measure available, and the accurate determination of the amount condensed by different radiators under any fixed set of conditions is the only safe and practicable way of comparing the heating efficiency of equal extent of rated heating surface that has yet been devised. In the October number of this Magazine notice was taken of experiments performed at Stevens Institute by Professors Denton and Jacobus, for the determination of the relative heating efficiency of different radiators. Their investigations, however, were directed to a comparison between plane and extended surface radiators. They found marked differences, not only between these two kinds of heating surface, but also between varieties of extended surface.

In the transactions of the American Society of Civil Engineers for July, 1894, is an account of a set of experiments performed by Mr. William J. Baldwin, author of a well-known popular treatise on steam heating, who gave an account of them in a paper read at the annual convention of the society held in June of the present year.

Mr. Baldwin's methods were identical in principle with that employed by Messrs. Denton and Jacobus, but the results were indicated by a graphic method, that is to say, they are shown by curves on a diagram accompanying the description of the experiments: A rectangle of convenient size is divided into squares by horizontal and vertical squares. Each horizontal side of one of these squares represents 100 British thermal units. Each vertical side represents two pounds of steam pressure. At the left of the diagram a column of figures indicate these pressures in pounds. At the bottom is a horizontal row of figures that indicate the number of pounds of water condensed, the numbers being respectively placed at the foot of each vertical line. It is evident that on this diagram may now be drawn lines which at any point will indicate the steam pressure, the difference of temperature at that pressure between the steam and the surrounding exterior air and objects, the heating value of a pound of steam condensed to water from any given pressure included in the scope of the diagram, and the condensation from any radiator tested at different temperatures. If the conditions of the tests be kept constant for different radiators, the curves of condensation thus traced form a ready means of comparing their various efficiencies at different temperatures and pressures; and the curves of actual condensation compared with a curve constructed independently to represent the theoretical condensation depending upon temperature difference will enable a determination to be made of the quantity of variation from this which occurs in actual practice.

The following results were obtained with four of the most widely used cast-iron radiators. While the total amount of condensation is greater with higher pressure and temperatures of the steam, exterior conditions remaining practically constant, the heating value of a pound of steam is a very little less at higher pressures than at lower pressures. Again the actual curves of condensation vary so little from the theoretical curve, that in practice it is safe to base estimates of heating capacity upon temperature difference at any pressure available for heating between the limits of say atmospheric pressure and 30 pounds, as indicated by the ordinary steam gage.

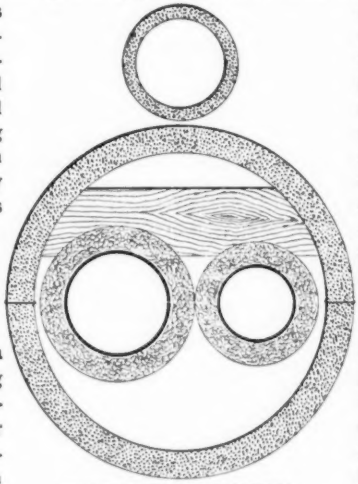
Drain, Soil, and Vent Pipes.

"PRINCIPLES to be observed in plumbing and specifying plumbing for a country house" are discussed in a paper contributed to *The Engineering Record* (Oct. 2) by Albert L. Webster, Civil and Sanitary Engineer. The subject is treated in a practical way without waste of preliminary words, and with an illustration which renders the text more readily understood. "Extra heavy, factory tested, cast-iron pipe is recommended for drain, waste, soil, and vent pipes. Standard cast-iron pipe is too light to permit of the joints being

securely caulked; in addition to which the metal in the body of the pipe is too scant, and as the core is frequently eccentric in casting, the pipe is very thin in spots, and blowholes are frequent." Minute and specific directions for putting in these pipes, and the traps in the system, arrangement of vent pipes, and connection of lead pipes with iron pipes are given. Equally exact and comprehensive specifications are given for cleanouts; yard, area, and court drains; safe wastes; drain trap; water closets; bath tubs; basins; sinks; grease traps; slop sinks; laundry tubs, and water supply. The leaving of all pipes as much exposed as possible instead of hiding them under wainscoting and plastered walls is advocated, and avoidance of running water supply pipes on outside walls where they are liable to freeze, is enjoined.

Underground Steam Pipes.

A DESCRIPTION of a method of protecting steam pipes and insulating them to retain their heat when run underground, is reprinted from the Sibley Journal in *Heating and Ventilation*. The accompanying diagram illustrates the method which was carried out in supplying steam to one of the buildings of the Iowa Agricultural College. The method is considered cheaper than the usual way of running pipes underground in brick lined trenches. A point of possible weakness in the method may lie in the wooden chairs used for supporting the pipes, which continuously subjected to heat while excluded from air may not prove durable. Otherwise there seems no objection to it.



UNDERGROUND STEAM PIPES.

"Both the steam and return pipes were laid in the same trench, and were laid with a grade of five-eighths of an inch in ten feet, and drained towards the boilers. The steam pipe was 5, and the return pipe 3½ inches in diameter. The trench was dug to grade. It was about 20 inches wide at the bottom and not much more at the top, the soil being clay, and the season dry. The depth varied from 4¼ to 9 feet. Below the grade of the trench was laid a line of 4-inch drain tile, which was connected with the drainage system of the college grounds.

"The outside covering or conduit for the pipes was constructed of 15-inch vitrified sewer tiles, laid with joints of the best Portland cement. To facilitate the laying the sewer tiles were halved lengthwise by means of a set hammer. It was cheaper to split the tiles than to buy half tiles from the tile works, the cost of whole and half tiles being the same per foot. The corresponding halves were marked for identification and were called uppers and lowers. The lowers were first laid and their joints made with Portland cement. In laying the lowers the proper grade was obtained by a long straight edge and level and verified by the Y-level and rod. At intervals of 6 feet wooden chairs were placed. These were sawed from 2-inch plank to fit the inside of the tiles and the outside of the covering of the steam and return pipes, and were dipped in asphaltum paint. The steam and return pipes were laid upon these chairs, two or three lengths being screwed together at one end for a start. The first section of each pipe was raised from the chairs, first at one end and then at the other, to allow of the placing of the non-conducting covering. Then two more lengths of each pipe were added to the line and the covering applied by raising the advancing end to clear the chairs by the necessary amount, and so on until the whole line was laid and covered. The uppers were then placed and all the joints

made in Portland cement. Back-filling completed the job. Expansion was provided for by ample offsets at the ends of the line. The non-conducting covering used on the pipes was mineral wool sectional covering; the sections were joined with pasted strips of heavy paper and cloth."

Typhoid Fever Germs and Sewerage.

IN the proceedings of the Sanitary Institute Congress, as reported in *The British Architect*, a paper of Dr. Klein on Typhoid Fever germs, and another by Prof. A. Roche (Dublin) on the spread of Typhoid Fever by sewers, both indicate that sewers may be avenues of conveyance of this disease to places not previously affected.

Dr. Klein's remarks related mostly to the typhoid bacillus, and pointed out the characteristics of *bacillus coli* by which it is distinguished from the true typhoid bacillus. Prof. Roche dealt with the conveyance of these germs through sewers. To prevent this ought to be the aim of the hygienist, and the safest and surest way of disposing of typhoid discharges was undoubtedly to destroy them by heat. All hospitals and public institutions should be obliged to do that.

Sir Charles Cameron (Dublin) argued that the evidence with regard to the spread of typhoid fever by milk or by water or through the sewers was of the very feeblest character. In Dublin they had a splendid water supply and a good system of sewerage, but their death-rate as to typhoid was one of the worst in the kingdom. The typhoid germs needed to be destroyed in the sick room itself, as once it was free there was no telling how it spread.

Dr. Sykes (St. Pancras) urged that bad drainage was very frequently responsible for the spread of typhoid. Dr. Clare (Hanley) remarked that the medical officer for Newcastle had attributed the immunity of that town from typhoid to the fact that it was built on a clay soil. Now Hanley and other of the "Potteries" towns were built on clay, and they had typhoid. The water was good, and the only conclusion he could come to was that the infection came from the manhole ventilators of the sewers, as the infected houses were those nearest the ventilators.

INDEX TO LEADING ARTICLES.

The journals quoted are indicated by initials, and their full titles are given in the opening pages of the Review. Other abbreviations are, Ill=Illustrated; W=Words.

Heating and Ventilation.

26026. Determining Size of Pipes and Registers to Heat a Given Amount of Space. George D. Hoffman (Met W-Oct. 20.) 800 w.

26417. Underground Steam Pipes. Ill. (H & V-Sept.) 450 w.

26418. New Electrical Heating Apparatus. Invention of H. Ward Leonard (H & V-Sept.) 600 w.

26421. The American Society of Heating and Ventilating Engineers. Suggestions for Its Advancement (H & V-Oct.) 5000 w.

26471. Steam Plant of the Grosvenor-Dale Company. Ill. (E R-Nov. 3.) 1800 w.

*22600. House Heating in Northern Countries (I S F-Nov.) 1000 w.

Landscape Gardening.

25807. Landscape Art and the Harlem Speedway (G & F-Oct. 10.) 1100 w.

26322. Transplanting Trees (G & F-Oct. 31.) 1200 w.

26323. Climbing Plants on Boston Buildings. Sylvester Baxter (G & F-Oct. 31.) 2000 w.

Plumbing and Gas Fitting.

26066. Principles to be Observed in Planning and Specifying Plumbing for a Country House. Ill. (E R-Oct. 20.) 2700 w.

25940. Good and Bad Plumbing (N B-Oct. 13.) 900 w.

*26149. The Plumber and the Sanitarian. John Mitchell (D E-Oct.) 1600 w.

Miscellany.

*25863. The Sanitary Institute Congress (B A-Oct. 5.) 2300 w.

*25904. Disease Caused by Sewer Gas, etc. (Pl D-Oct.) 900 w.

26419. Smoke (Abstract) W. H. Blauvelt (H & V-Oct.) 700 w.

26420. In the Time Before Chimneys. Ill. E. C. Weaver (H & V-Oct.) 2200 w.

Serials.

25500. Gas Stoves as They Are and as They Should Be. Adam Gasmann (P A-Began Oct. 1—2 parts to date—15 cts. each).

25716. Power and Heating Plant, Manhattan Life Insurance Building. Ill. (E R-Began Oct. 6—2 parts to date—15 cts. each).

26132. Sanitary Plumbing. F. B. Brady (I C B-Began Oct. 12—Ended Oct. 19—2 parts—30 cts. each).

We supply copies of these articles. See introductory.

ELECTRICITY

Defective Telegraphic Construction.

ON election day in November occurred one of those periodical storms, consisting of a combination of rain, snow and ice, which once in every two or three years make a total wreck of the telegraphic lines over a wide area of country. The damage in the present instance seems to have been mainly confined to a section of country between New York and Boston, within which area, according to the statement of a local newspaper, over 8000 poles were thrown down, and their burden of wires tangled into almost inextricable confusion. The *Springfield Republican* (November 13) calls attention to the fact that the Western Union company are replacing and resetting the same old poles, and sarcastically inquires whether that company is not getting ready to unload its decayed poles and wires on the United States government at a round price, when popular patience has been quite exhausted. It is hardly necessary to assume so far fetched an explanation as that. The trouble is, not that the poles are weak or decayed, but that they are overloaded. Each line of poles carries three or four times as many wires as it should, either for satisfactory operation, or for safety in case of a severe storm. The poles are usually not broken under the added weight of snow and ice, but are simply pried out of the ground. Every highway and railway between New York and Boston is already inconveniently crowded with lines of poles, and every line of poles is overburdened with wires. There would seem to be only two ways out of the difficulty. One is for the telegraph companies to purchase an independent right of way 50 or 100 feet wide, between the principal cities, and erect thereon a structure strong enough to withstand such storms as that of last month, or else the trunk lines must be put underground. A few years ago, the latter alternative would have been almost an impossible one, within reasonable limits of cost. But so great have been the improvements in the manufacture of insulated wire and cables, that it is an open question whether, if it were to-day required to build a new line of 100 wires from New York to Boston, an underground line would not be the cheapest in first cost, to say nothing of the subsequent expense of maintenance, and the advantage of being able to operate every circuit at full speed at all times, regardless of the condition of the weather. Nothing is more certain than the fact that the present system of construction has reached the limit of its usefulness on such main routes as that from Boston, to New York, Philadelphia, Baltimore and Washington.

Electricity on Elevated Railroads.

THE question whether the elevated railroad of the future will be operated by steam or by electric locomotives has given rise within the past year to no small amount of discussion. "With the Metropolitan of Chicago now equipping twenty miles of elevated road for electric traction at a cost of $400,000 more than steam equipment would have necessitated; with the Northwestern arranging to equip electrically, and the Lake street and Alley 'L' companies wishing they had done so, it would seem,"—says Mr. B. J. Arnold in the *Western Electrician* (October 10),—"that the question has been pretty effectually settled in favor of electricity by those most competent to judge." Mr. Arnold believes the elevated road of the future will be built substantially on the following general lines: "The structure will be of steel, about two-thirds the weight of the present structures built for steam service. The current will be carried to the trains by a trolley-line consisting of a cheap grade of

railroad rails, which it has been found can be purchased and laid for but little over half the cost of copper conductors of a given conductivity, or by a specially rolled square steel bar. The active or 'live' trolley will be supplemented by one or more similar rails or bars as the distance from the power-house and the number of trains increase. Sliding-contact trolleys have thus far proven preferable, and will probably be adhered to for future work at higher speeds. So far as present indications point, we shall maintain the direct current motors attached directly to the axles of the forward or motor car. . . . Comparisons between the Liverpool overhead railroad and the City & South London underground lines show that the tractive force per ton of locomotive is as 730 to 367, or a ratio of nearly two to one in favor of the motors mounted directly on the motor car." Mr. Arnold thinks the electric brake of the future will be operated by the counter current generated by the motor armatures, and will be entirely independent of the current from the trolley or any external source. "In the power-station, the tendency will be towards larger and fewer units of power, resulting in decreased cost for labor and repairs. Direct coupled engines and generators will be used exclusively. A well designed and properly operated power-station should be able to deliver a kilowatt hour on the switchboard for one cent, exclusive of motormen's wages and interest, but including all labor, fuel and miscellaneous expenses incidental to the production of power." Mr. Arnold gives a table showing the estimated cost of power for operating an elevated train of various weights at various speeds, assuming the price of bituminous slack at $1.25 per ton. According to this, a 6-car train at 15 miles per hour, will cost 12.46 cents per train mile. These figures, he thinks, ought to be possible under present practice.

The Heilmann Locomotive.

THE *Railroad Gazette* (November 9) contains a long editorial on this much discussed and apparently absurd contrivance for combining steam and electric traction, which has been in experimental use during the past year on the Western railroad of France. Now that this railroad has undertaken to build two more of these machines, with certain modifications and improvements, and inasmuch as various technical writers have thought it worth while to discuss it as a possible machine for practical service, the *Gazette* has sought to make a somewhat critical analysis of the theory underlying its construction and of its working details. The new engines are to have two eight-wheel bogie trucks and eight electric motors, one truck carrying the boiler and the other the engines and dynamo. Each locomotive is provided with a 1500 horse-power vertical Willans engine and a dynamo of corresponding capacity. The boilers are of the ordinary locomotive type. The claims made for the Heilmann locomotive are, that with it, higher speed can be made with greater safety, less injury to the track and with considerable economy of fuel. The *Gazette* compares the performance of the Heilmann machine, as given by Mr. Du Riche Preller in a recent number of *Engineering*, with that of a typical engine of the New York Manhattan railway in this country, very much to the advantage of the latter. It says that "the average local train service in this country is much heavier than that performed by the Heilmann motor; the trains are about four times as heavy, the speeds as high or higher, and the locomotive and tender combined are only about half the weight of the Heilmann motor. Four times the work in every-day service is done with about half the weight of locomotive." The writer of the article then goes on to compare the two systems, by showing what can be theoretically got out of a pound of coal in each. He figures that in the Willans engine, under the conditions given, a horse-power hour can be produced from 3.84 pounds of coal, as against 4.34 pounds in a compound locomotive running under fair conditions. Allowing 8 per cent. loss in internal friction for the steam locomotive, and 10 per cent. for the Willans engine and its dynamo, plus 10 per cent. allowed for average loss in the dynamo under

varying load, each horse-power hour of current will require 4.8 pounds of coal. The efficiency of the motors is taken at 70 per cent., which is surely high enough, and this brings the coal per horse-power hour to deliver at the driving axle 6.85 pounds as against 4.73 pounds required by the steam locomotive. Hence the Heilmann locomotive will require 45 per cent. more fuel than the steam locomotive to do the same work, to say nothing of its being twice as heavy. "No one," says the *Gazette*, "who has not examined the details of construction of the Heilmann motor, can appreciate the mass of complication of detail. It has all the disadvantages of the hard-driven locomotive boiler; the locomotive running-gear, cylinders, electric generating plant, a small steam-engine for exciting the field-magnets, eight electric motors with their commutators and brushes, eight or sixteen flexible clutches, and eight hollow shafts surrounding the driving axles; in fact it has all the troubles incident to a stationary electric plant, an electric street-car and a steam locomotive combined, and has not the advantages of any one of these."

The trials which have been made with the Heilmann motor appear for one thing to have demonstrated the inadequacy of the three-phase alternating motor, as at present constructed, for railroad service. Such a motor was designed for the Heilmann machine by C. E. L. Brown, but finding that it had insufficient starting torque, he finally returned to the plain series-wound motor, which so far appears to hold its place as the only type suitable for use under the necessarily varying conditions of speed and load in railroad work, where frequent stops must be made at crossings, for signals and at way stations.

Conditions of Maximum Economy in Electric Conductors.

IN 1881, Sir William Thomson, now Lord Kelvin, read before the British Association a most important paper on the conditions of maximum economy in the transmission of electric energy, in which the conclusion was reached that this maximum is secured when the cost of power wasted is equal to the cost of interest, depreciation, repairs, etc., on that part of the cost of the line that increases with the cross section of the conductor. In the *Electrical Engineer* (October 31) Professor W. A. Anthony observes, that notwithstanding that Professor Ayrton had pointed out some years since, that Kelvin's law held good only in certain cases, the idea still seems to be generally prevalent that it has a general application. Prof. Anthony goes on to cite a number of examples involving conditions which might, and in fact, do, often occur in practice, in which the application of Kelvin's law leads to results which are manifestly absurd. One of these is the case of a water-power in which it is desired to employ the whole power to the best advantage while the admissible pressure is limited by conditions of line insulation. In such a case, the problem is, not to deliver a certain fixed quantity of energy at the least possible expense for transmission, in the form of additional energy and interest and repairs on line, but to divide the energy available into two parts, one to be delivered and the other to be used to effect the transmission, in such manner that the returns from the part transmitted shall bear the largest possible ratio to the total cost of generation and transmission. The application of Kelvin's law to this case might, and often would, give such a size of conductor that the entire available energy would be consumed in it. Professor Anthony points out that there may be as many as eleven different cases in all, most of which may be solved for a condition of maximum economy, but in only one of which this condition is satisfied by the conditions laid down in Kelvin's law. He regards it as a self-evident proposition that the maximum economy in any given case will be reached when the revenue from the energy delivered bears the largest possible ratio to the total expense of generation and transmission. When the quantity of energy to be delivered is given, the condition of maximum economy is that the cost of transmission shall be a minimum. When on the other hand,

the quantity of energy that can be generated is given, the condition of highest economy no longer requires that the cost of transmission thall be a minimum, since that might in some cases demand the entire available energy merely to effect the transmission. Professor Anthony also takes occasion to criticise the employment of the term "waste energy" to denote the energy consumed in transmission. In transporting coal from the mines to the consumers, no one thinks of calling that part of the coal which is used in the locomotives "waste coal." What is miscalled "waste energy" is an entirely legitimate part of the expense of transmitting energy from the transmitter to the receiver, and is no more waste in any proper sense than are interest and depreciation.

Sine Curves of Alternating E. M. F.

A COMMUNICATION from Siemens & Halske of Germany relating to this much-discussed subject appears in the *Electrical World* (October 20). The authors distinguish three typical forms of curve; the flat-topped curve, the peaked curve and the sine curve, which lies between the first two forms. So far as incandescent lamps are concerned, the form of the curve appears to be immaterial, but in operating arc lamps, it is of considerable importance. The potential difference between the carbons of a burning arc lamp, other things being equal, is greater in proportion as the curve is flatter. With a peaked curve this potential difference is 25 per cent. less than with the flat curve. The amount of light produced per watt consumed in the lamp is also 20 per cent. less. The humming noise of the arc lamp is less with a sine curve than either with a peaked or a flat curve. In transformers and motors, the peaked curve has the advantage over the flat form in that with the same mean e. m. f. the energy of magnetization is less. In an experiment quoted, the energy of magnetization was found to be 43 per cent. higher in the case of the flat curve. This however, but slightly lowers the efficiency of the conversion as a whole. The torque and output of a motor are not much influenced by the form of the curve. The authors point out that dynamos giving different curves cannot advantageously be run in parallel, and that arc lamps must be regulated for the special form of curve for which they are to be used. From these and other considerations the authors think that it would be very advantageous if all makers of alternate current apparatus would decide to use some one form of current curve. It would be an advantage to choose a curve having as simple a mathematical formula as possible; a condition which is satisfied by the sine curve, which is therefore recommended as the form to be preferably chosen as the universal current curve in alternating practice.

Electric Lighting of Isolated Buildings.

FOR some reason or other, comparatively little has been done in this country in the way of providing an efficient and economical means for electrically lighting first-class residences situated in isolated localities. Thus far, probably nothing better has been devised than a storage battery plant of adequate capacity, arranged to be charged by a dynamo driven by a gas or petroleum engine. A somewhat verbose description of an interesting plant of this kind is given in the *Western Electrician* (October 13) accompanied by a number of illustrations. The power-house containing the electric apparatus is situated about 500 feet from the mansion to be lighted. The latter is wired on the three-wire system, the conductors being placed in interior conduits. A Lewis 15 horse-power gasolene engine is belted to a 12 k. w. shunt-wound Edison dynamo, giving 125 volts and 96 amperes at 1600 revolutions. The storage-battery consists of 60 chloride accumulator cells aggregating 250 ampere-hours' capacity. These are placed on shelves in four vertical rows of 15 cells each. A switchboard of black slate carries all the necessary instruments and appliances. The buildings are at present wired for 256 lights. In operating the plant, the usual practice is to run the dynamo during the day to charge the storage-battery, and to run the house lights at night directly from the battery. In the

event of an unusual load, the dynamo may be thrown into service and current furnished direct for the entire lamp capacity of the plant. It is computed that the average cost of running 100 lamps 4 hours per day, including gasolene, lamp renewals, oil, etc., but not depreciation of storage battery is about $26 per month.

Electric Distribution in Small Towns.

THE *Electrical Engineer* (October 31) has an interesting account of an electric plant at Buchanan, Mich., a town of about 2500 inhabitants, which is operated by water-power from the St. Joseph river. The electrical equipment at the power-house comprises one 45 kilowatt 500-volt generator for motor work; one 65 kilowatt 1000-volt alternator, and one 60-light 10-ampere arc dynamo. These are driven by three turbines of 150 horse-power each, mounted on vertical shafts and driving a single main shaft by bevel-gears, at a speed of 250 revolutions per minute. The pulleys which drive the dynamos are mounted on quills on the main shaft and provided with friction clutches, so that any pulley may be started or stopped at pleasure. The present output comprises 700 16 candle-power incandescent lamps; 45 2000 candle-power arc lamps, and motors aggregating 55 horse-power. The consumption is rapidly increasing. The price for commercial and public arc lights, running till midnight, is $50 per year; for commercial 16 candle-power lights, $6 per year, and for domestic lights, $18 per year for the first three lights and $1 per year for each additional light, the customers paying for renewals. For motor service, $20 per horse-power per year is claimed for over 50 horse-power, and $25 per horse-power per year for less. Three men run the entire plant both for day and night service.

Fly-Wheel Accidents in Electric Power-Houses.

IN the *Electrical World* (October 13) appeared a communication from Mr. T. C. Coykendall, suggesting as an explanation for the somewhat numerous instances of the breaking of fly-wheels in electric power stations within the past two or three years, the tangential stress caused by the sudden and heavy load thrown on the engine upon the occurrence of a short circuit on the dynamo. In the same journal (October 20 and 27 and November 3 and 10), the subject-matter of Mr. Coykendall's letter is discussed at length by a number of eminent authorities in mechanical engineering, among whom may be mentioned Professor R. H. Thurston, Charles E. Emery, William D. Marks, and T. Carpenter Smith. The general consensus of opinion appears to be that such disasters seldom arise from the particular cause assigned by Mr. Coykendall, but are in almost every instance found to be due to some defect either in the construction or operation of the governor, which permits the engine to race and to suddenly increase the centrifugal strain upon the fly-wheel beyond the safety limit. Mr. Smith says he has kept a rough list of such accidents for two years and finds that there have been over thirty of them, causing a large total damage as well as the loss of several lives. He calls attention to the fact that but few of these accidents have occurred in rolling-mills, where the variations in load are as great if not greater than in the electric service and are always accompanied with a much more sudden shock or jar, but on the other hand most of them have happened in the manufacturing or electric service in which the wheels have not only served as fly-wheels but also as transmission wheels, the power being taken off the rim either by belts or gears. Mr. Smith also notes that in nearly every reported case the wheels have been of large diameter and the speed of the engine either slow or moderate, and adds that he has not on record a single case of a really high-speed engine having broken either a fly- or transmission-wheel. This would seem to indicate that immunity from such accidents might be had in the use of heavy wheels of small diameter driven at high speed. The question is one of great practical importance as well as theoretical interest, and the *Electrical World* deserves the thanks of the profession for having opened its columns to a discussion of the

matter at the hands of so many recognized authorities.

Cost of Electricity in a Temporary Plant.

ACCURATE figures giving the cost of producing electricity for light and power under different conditions met with in practice are always of value, and those deduced from the working of the temporary plant erected for the California Exposition, are of peculiar interest. These are given in great detail in a paper by W. F. C. Hasson and A. M. Hunt in *Electricity* (October 17). There were throughout the Exposition a total of 791 arc and 9112 incandescent lights; the hours of incandescent service were 1937, and the charge was $8 per lamp; the days of arc service 154, and the charge $75 per lamp. The total cost of materials and labor for installing the electric plant was $15,061.37. The total cost of installation and operation per 16 candle-power lamp, during the period of the exposition, was for the Electrical department $2.30; for the Engineering department $2.49; grand total $4.79. In considering the cost of operation above given, the authors call attention to the fact that the plant was in no sense well designed for economic operation, inasmuch as both engines and dynamos were operative exhibits which had to be matched together as well as circumstances would permit. It is stated that if all the construction had been done by the Exposition forces, the cost of the work would have been at least 35 per cent. less than it actually was. These figures may be of value in estimating the cost of future work of a similar nature.

Compounding of Dynamos.

THE strength of the magnetic field of a dynamo depends upon the number of ampere turns enveloping its magnetic circuit. When, therefore, an increased current is drawn from the armature, a corresponding augmentation in voltage is required to drive this increased current through the armature, and this can only be provided by strengthening the field. A shunt-coil cannot do this, for the current in the shunt necessarily tends to diminish as the load becomes greater. Hence an additional coil is placed upon the field which is connected in series with the armature, and in this coil the current will evidently increase as the load increases. This operation is termed compounding the dynamo. In some of the text-books, the dimensioning of the series coil is made to appear to be a very complicated matter, though in reality nothing can be more simple. Mr. George T. Hanchett, in the *Electrical World* (November 10), gives a method of practically determining the number of turns which should be given to the series coil of a compounded dynamo, together with an illustrative example which makes the whole matter quite clear, and may be commended to the attention of those interested in the subject. Mr. Hanchett points out that inasmuch as the series coils of a compound machine are nothing more than regulators for the magnetic reactions of the armature and the lost volts consumed in driving the current through its coils, the excellence of the design of any given machine may be roughly estimated by regarding it as inversely proportional to the number of turns in the series coils, inasmuch as the lost volts and armature reactions of a good machine are very small.

Welsbach Burners vs. Electric Lamps.

HOW to meet the competition of gaslight, as furnished by the Welsbach burner, with electric light at the lowest figure at which the latter can be supplied is a conundrum propounded but left unanswered by Mr. Ed. M. Highland in *Electrical Engineering*. "To compete with gas we must get an equal amount of light, in candle power, per pound of coal used, or be able to deliver the product to the consumer at a proportionately cheaper rate than gas is being delivered. The committee on statistics of the National Electric Light Association report 208 watt hours per pound of coal as the best duty, and gives the average of sixty-five electric light plants as 91.6 watt hours per pound of coal. This average is entirely too low to use even in argument. So we will take the best showing made, 208 watt hours. This 208 watt hours will supply 3.7 incandescent lamps

of sixteen candle-power each of the type known as 3½ watt per candle efficiency, making a total of 59.2 candle-power per pound of coal. The same amount of the same kind of coal consumed in a gas-works will yield four cubic feet of gas. The Welsbach burner consumes three feet of gas per hour and gives a sixty-candle power light, or the equivalent of eighty candle-power per pound of coal." A comparison of expenses other than coal is very much in favor of gas lighting as compared with electric lighting; and the conclusion seems unavoidable that "electricity is sold as cheap now as it is possible with present machinery. Gas can be sold from twenty-five to fifty per cent. less than at present, and still leave a good margin for the stockholders. How can electric light companies meet this competition?"

Mr. Perry's article printed in this Magazine for November, offers at least a partial answer to this question.

Another partial solution is perhaps afforded in the paper of Lieut. F. N. Lewis, on the generation of electric power by windmills, printed in this number, which contains some statements relative to economies secured by the use of wind-power that will command attention.

It is also possible that Mr. Highland's figures may be disputed, as there is always danger of overlooking something in estimates of this sort.

INDEX TO LEADING ARTICLES.

The journals quoted are indicated by initials, and their full titles are given in the opening pages of the Review. Other abbreviations are, Ill=Illustrated; W=Words.

Lighting.

25853. Storage Batteries for Private House Lighting. Ill. (W E-Oct. 13.) 1800 w.

25866. On the Subdivision and Distribution of Artificial Sources of Illumination. William A. Anthony, with Discussion (P A-Oct. 15.) 5000 w.

25951. Storage Battery Decision. Letter from W. W. Gibbs (E R N Y-Oct. 17.) 1200 w.

*26056. The Electricity Works at Worcester. Ill. (E E L-Oct. 12.) 7000 w.

26140. Fire from Contact with Electric Wires. William Brophy (A G L J-Oct. 22.) 2600 w.

*26218. Notes on the Electric Lighting of the City of Melbourne. (Abstract.) J. Arnot (I. & I-Oct. 19.) 2500 w.

26247. A Review of the Underwriters' Recent Rules Covering the Use of 500 Volt Fuses. Walter E. Harrington (W E-Oct. 27.) 1800 w.

26370. A Dresden Electric Plant. Ill. Robert Grimshaw (E W-Nov. 3.) 1500 w.

26385. Charges for Incandescent Lighting by Southern Stations (T-Nov. 1.) 1600 w.

*26435. On the Degree of Incandescence of Lamps. A. Crova (El-Oct. 26.) 1000 w.

Power.

*25764. Generating Electricity by Wind Mills—A New Factor in Power Transmission. Ill. I. N. Lewis (E Mag-Dec.) 3500 w.

*25877. The "Halles" Station. G. Claude (E R L-Oct. 5.) 3800 w.

†25965. Test of a Closed Coil Arc Dynamo. Ill. R. B Owens and C. A. Skinner, with Discussion (T A I E E-Oct.) 3500 w.

†25966. Relative Advantages of Toothed and Smooth Core Armatures. Alton D. Adams, with Discussion (T A I E E-Oct.) 3300 w.

†25972. Theory of Two and Three Phase Motors. Samuel Reber (T A I E E-Oct.) 1800 w.

†25973. Theory of the Synchronous Motor. Charles Proteus Steinmetz (T A I E E-Oct.) 2400 w.

*26234. Electric Power in Factories. (Abstract.) Thomas Richardson (El-Oct. 19.) 3800 w.

26298. Electric Elevators. Ill. George Edward Harding (A A-Oct. 27.) 6500 w.

26329. Economical Production of Power by Electrical Driving (E N Y-Oct. 31.) 2500 w.

26346. The Earliest Electric Passenger Boats and Passenger Cars (ScA-Nov. 3.) 900 w.

*26433. Electric Traction by Accumulators in Mines (El-Oct. 26.) 1100 w.

26534. The Water-pail Forge and Modifications. Nelson W. Perry (E N Y-Nov. 7.) 1700 w.

26594. Practical Compounding of Dynamos. George T. Hanchett (E W-Nov. 10.) 1500 w.

Telephony and Telegraphy.

*26061. Notes on the Anglo-American Telegraph Company's 1894 Electric Cable. Ill. Arthur Dearlove (El-Oct. 12.) 1900 w.

Miscellany.

25772. A Simple Formula for Magnetic Windings. Fred Brainerd Corey (E E N Y-Oct.) 500 w.

25835. Relation Between Line Wire Losses and the Over Compounding of Dynamos. E. P. Roberts (E W-Oct. 13.) 1000 w.

25852. The Electric Era.—The South's Advancement in Electric Railroad and Light and Power (M R-Oct. 12.) 3000 w.

25937. Cost of Light and Power for a Large Temporary Plant. W. F. C. Hasson and A. M. Hunt (E N Y-Oct. 17.) 1500 w.

We supply copies of these articles. See introductory

†25967. Standardizing Electrical Measuring Instruments. Elmer G. Willyoung, with Discussion (T A I E E-Oct.) 6200 w.

†25968. An Optical Phase Indicator and Synchronizer. Ill. George S. Moler and Frederick Bedell (T A I E E-Oct.) 1200 w.

†25969. A Reliable Method of Recording Variable Currents Curves. Albert C. Crehore, with Discussion (T A I E E-Oct.) 4000 w.

†25970. Resonance Analysis of Alternating and Polyphase Currents. M. I. Pupin (T A I E E-Oct.) 7000 w.

25984. The Riker Storage Launch Operated from Trolley Circuit at Stamford, Conn. Ill. (E E N Y-Oct. 17.) 600 w.

†26037. "What Electricity Is" (N S R-Oct.) 2400 w.

26102. The Oscillator.—An Account of Nikola Tesla's Great Invention. (From the N. Y. Times.) (R A-Oct. 19.) 1700 w.

*26126. Modification of Anderson and Kennelly's Method of Localizing a Fault by the "Earth Overlap Test." A. Jordan and W. Schönan (E R L-Oct. 12.) 500 w.

*26129. On Persistent Electric Oscillations and Their Effects. H. Ebert (E R L-Oct. 12.) 1500 w.

26195. Hertzian Waves, Carbon Microphones and "Coheres." William James Morton (E E N Y-Oct. 24.) 1000 w.

*26237. Capacity of Conductors (E R L-Oct. 19.) 900 w.

26341. On Economy in Conductors and the Limitations in the Applicability of Kelvin's Law. William A. Anthony (E E N Y-Oct. 31.) 2000 w.

26347. High Voltage Electric Shock Produces Insensibility to Pain (ScA-Nov. 3.) 700 w.

26371. Cost of Light and Power for the California Midwinter International Exhibition. W. F. C. Hasson and A. M. Hunt (E W-Nov. 3.) 1000 w.

26414. The Magnetic Needle. A. W. Elkins, with Discussion (C M R-Oct.) 2500 w.

*26524. Earth Currents. E. O. Walker (E R L-Oct. 26.) 1500 w.

*26526. Choking Coils vs. Resistances. Rankin Kennedy (E R L-Oct. 26.) 700 w.

*26528. Regulation of Phases in Working with Alternating Currents. Ill. C. L. Imhoff (E R L-Oct. 26.) 700 w.

26618. New Monocyclic Alternating System for Simultaneous Light and Power Work. Ill. (E I-Nov.) 1300 w.

Serials.

11560. Electric Motive Power. Ill. Albion T. Snell (El-Began March 17, 1893—22 parts to date—30 cts. each).

18661. Alternate Current Working. Harris J. Ryan (E W-Began Jan. 6—8 parts to date—15 cts. each).

11932. What I Don't Know About Electricity (E I-Began Feb.—3 parts to date—15 cts. each).

22059. Practical Notes on Dynamo Calculations. A. E. Wiener (E W-Began May 19—16 parts to date—15 cts. each).

23866. Electro Dynamic Machinery. E. J. Houston and A. E. Kennelly (E W-Began July 21.—15 parts to date—15 cts. each).

24198. Action of a Transformer with a Condenser in Parallel with the Secondary. F. Bedell and A. C. Crehore (E W-Began Aug. 11—4 parts to date—15 cts. each).

24508. Magnetic Leakage in Dynamo Electric Machinery. Ill. Alfred E. Wiener (E E N Y-Began Aug. 22—Ended Nov. 7—10 parts—15 cts. each).

24536. Principles of Dynamo Design. Newton Harrison (E A-Began Aug. 25—9 parts to date—15 cts. each).

25095. Postal Telegraphs. James Bell (E L-Began Sept. 7—8 parts to date—30 cts. each).

25105. Standard Units for Electrical Measurement. (E R L-Began Sept. 7—4 parts to date—30 cts. each).

25129. The Incandescent Electric Lamp Problem. Sydney F. Walker (C G-Began Sept. 7—2 parts to date—30 cts. each).

25482. The Chemical Theory of Accumulators. E. J. Wade (El-Began Sept. 21—5 parts to date—30 cts. each).

25483. The Construction of Resistances. D. K. Morris (El-Began Sept. 21—Ended Oct. 5—3 parts—30 cts. each).

25599. Notes on the Management of Railway Power Stations. Ill. George T. Hanchett (E W-Began Oct. 6—5 parts to date—15 cts. each).

25743. The Board of Trade Standards and Standardizing Laboratory (E E L-Began Sept. 28—2 parts to date—30 cts. each).

25876. The Electric Motor and Some of Its Applications. Ill. (E R L-Began Oct. 5—2 parts to date—30 cts. each).

25895. The Design and Specification of Electric Lighting Works for Architects and Civil Engineers. Howard Pentland and Alfred H. Gibbings (E L-Began Oct. 5—4 parts to date—30 cts. each).

25897. The Velvo Battery with Mechanical Depolarization. Critical Review of Tests (E L-Began Oct. 5—1 part to date—30 cts).

25907. The Alternating Current, Its Generation and Distribution. George D. Shepardson (E I-Began Oct.—2 parts to date—15 cts. each).

26235. The Diseases of Dynamos. (E R L-Began Oct. 19—2 parts to date—30 cts. each).

26377. Resonance Analysis of Alternate Currents. M. I. Pupin (A J S-Began Nov.—1 part to date—45 cts).

26518. The Surplus and Deficit Theory of Electricity. W. Perren Maycock (E E L-Began Oct. 26—1 part to date—30 cts).

26592. Electrical Power Transmission. Louis Bell (E W-Began Nov. 10—1 part to date—15 cts).

We supply copies of these articles. See introductory.

INDUSTRIAL CHEMISTRY

Recent Applications of Cellulose.

AN interesting popular account of the preparation of pure cellulose and of the many remarkable and valuable products, old and new, derived from it appears in *Knowledge*. While cellulose is insoluble in ordinary solvents, it yields to some special reagents, of which the most important are the ammoniacal solution of cupric hydrate and the solution of zinc chloride in hydrochloric acid. The solvent power of the former is the basis of the manufacture of "paper boards," made by submitting sheets of unsized paper to a superficial action of the solvent and compressing a series of prepared sheets by rollers, the result being a board-like material waterproof even at the boiling point.

Nitric acid acting on blotting paper produces a curious result; the composition remains unchanged but the strength of the paper is increased tenfold, while the linear extent is decreased 10 per cent. Stronger nitric acid and mixtures of nitric and sulphuric acids, acting on cellulose, produce gum cotton and the various pyroxylines, from which collodion is made by solution in alcohol and ether. Celluloid consists of a mixture of pyroxyline and camphor, and was first prepared by Hyatt, of Newark. Artificial tortoise shell is made by welding plates of differently tinted celluloids.

Sulphuric acid acting on unsized paper produces vegetable parchment, etc.

Mercerization is produced by the action of alkalies on cotton cellulose, and when cotton cloth is thus treated the fibers are contracted 20 per cent., with an increase of 30 to 35 per cent. in strength, and an increased affinity for certain dyes.

A recent product is cellulose thiocarbonate, a substance which promises to rival celluloid in importance, as it has not the inflammability of celluloid; and to take the place of ebonite for purposes where the brittleness of the latter is a disadvantage. It is produced by the action of carbon bisulphide on mercerized cotton, or by bringing together two parts of cellulose, one of caustic soda, two of the bisulphide, and eight of water. By varying the proportion of the constituents a series of valuable products are obtainable, one resembling the softer varieties of india-rubber and another practically indistinguishable from horn, being hard, tough and perfectly adapted for turning. It is readily colored. The writer of the article quoted considers the importance of this new discovery to be manifest, especially in view of the failing supplies of ivory, for which it, like celluloid, is a substitute.

Carbon Blacks from Natural Gas.

AN industry peculiar to America, and one of considerable importance, is that of the manufacture of black from natural gas. A very thorough account of its history and the methods employed has been given by Mr. G. L. Cabot, of Boston, to the Scotch section of the Society of Chemical Industry and appears in its *Journal*, and has been reprinted in the *Scientific American Supplement*. The substance thus obtained has many trade names, as "carbon black," "hydro-carbon black," "gas black," "satin gloss black," "jet black," etc. It is quite different in quality from lampblacks made from oily or resinous substances, and also from the blacks once made on a small scale from ordinary illuminating gas. As Mr. Cabot says, the merit of the invention of these blacks, as with so many important discoveries, belongs to no one person, but must be divided among many. However, the first successful factory for making blacks from natural gas was built at Cumberland, Pa., in 1872, and was soon followed by many others seeking to utilize the natural gas then going to waste in enormous quantities and regarded as a nuisance by the petroleum men.

The original process employed a series of flat cast-iron pans filled with water, which was thought to improve the quan-

tity and quality of the product. Under the pans were lines of common gas tips, the flame from which impinged on the iron and deposited the soot. At intervals a car provided with a scraper was drawn under the rows of pans, collecting the black. Of all the later factories, it is said that none have produced more black per thousand feet of gas or of softer quality; but important mechanical improvements were rapidly evolved. Water cooling was abandoned as an unnecessary complication; the pans were replaced by plain plates, also by concave plates. Various systems of collecting the black on revolving rollers with stationary scrapers; on revolving disks, up to 24 feet in diameter, either solid or with ventilating holes, with stationary burners and scrapers; on smaller rings similarly arranged; and on stationary plates with moving burners, scrapers and collectors, in great variety, were patented and introduced. In modern plants the product is handled entirely by machinery; is removed from the chamber by screw propellers, sifted and bolted, elevated into bins, and packed mechanically. The product is so light (5 lbs. per cubic foot) that it has to be compressed, and the plungers of the presses, after much difficulty from leakage in attempting to expel the air, are now faced with sheep pelts, which detain the black but allow the air to pass.

The first lots brought $2.50 per pound, but the price rapidly fell until in 1883 it reached 24 cents; later 8, 5, and even 3 cents were the net returns to the manufacturer, but recently the price has improved. The annual product has increased until, for 1894, it is estimated at 3,000,000 pounds.

The chemical composition of carbon black is about 92 to 93 per cent. carbon, 5 to 6 per cent. oxygen, and 1 per cent. hydrogen, with no trace of mineral matter. To the credit of the trade, Mr. Cabot affirms that no adulteration has been found.

Carbon blacks are used for printer's ink, paints, "mineral black," stove polish, shoe leather, rubber goods, coloring cement and mortar, artificial stone, stencilling, mixing with other blacks to improve them. The author makes comparisons between carbon blacks from gas and ordinary lampblack.

In a note on the foregoing paper Mr. Robert Irvine describes the older attempts to make blacks from illuminating gas, considers the proposition to make blacks from oil shale impracticable, and furnishes additional data.

Monazite.

UNTIL quite recently this peculiar mineral has deserved its name, the "lonely" or "solitary" mineral, having been found only in very small quantities in such widely separated localities as Finland and Cornwall, Norway and Bohemia. The New York *Sun* and the Boston *Jonrnal of Commerce* announce the recent discovery of comparatively large quantities in North Carolina, where a brown sand unfamiliar to the miners was met with in the placers. A sample was sent to a German analytical chemist, who pronounced the mineral monazite. Its most striking characteristic is its extreme refractoriness. An illuminating company happened at the time to be in need of just such a material, and hearing of the discovery sent experts to North Carolina to investigate, who found it "by the ton." It occurs along the river banks and in the river beds, in the clefts of rocks and in gullies, but it took large quantities of the crude material to furnish it in the shape required. Purchases for shipment to Germany were made at a price of from $150 to $200 a ton. This induced further search, and it is reported to have been discovered in eight counties of the State, where there is now a monazite boom, according to our authority.

Products of Combustion from Argand and Welsbach Burners.

THE results of researches on the chemical composition and sanitary effects of the products of combustion of coal gas as yielded by Argand and Welsbach burners have been communicated by M. N. Grehaut to the *Comtes Rendus*, and the note has been translated for the *Chemical News* and again appears in the *American Manufacturer*. The author first describes his apparatus and method and their verification, and then gives his results. He finds that in the products of combustion from

the Argand burner there exists (besides carbon dioxide) a trace of gas containing carbon, but the proportion is so slight that it may be estimated at 1-15,000, carbon monoxide (the poisonous gas) being absent. With the Welsbach burner, which gives so white and dazzling a light, the case is different. Formene or carbon monoxide, or a mixture of both, were found in the products of combustion to the amount of 1-2580. In the former instance physiological tests showed no carbon monoxide present; in the latter a decided result was obtained. The author's conclusion is that "from a sanitary point of view it is very important to allow the products of the combustion of coal gas to escape into the open air, especially if derived from the Welsbach burner."

Manufacture of Sulphuric Acid.

A VERY complete, though necessarily condensed, summary of the history of the sulphuric-acid manufacture from its inception in 1746 down to the present is given by the *Revue Technique*, concluding with a description of the new Barbier process. The article has been translated for the *Scientific American Supplement*. Full details of the operation of this process and an illustration of the apparatus are presented. It is claimed that the arrangement, under a simple and practical form, realizes the long-sought problem of the manufacture of sulphuric acid without lead chambers.

The plant consists of pyrites furnaces and three small reaction towers, interposed between a sort of Glover or denitrating tower and a Gay Lussac tower of peculiar construction. These various towers are filled with small cells with perforated bottoms, that present from 70 to 75 square meters of friction surface per cubic meter of filling. Beneath the towers, and in communication with them, are arranged basins in ascending series which are heated directly by the hot gases from the roasting furnaces. These basins receive on the one hand the dilute sulphuric acid and the nitric acid from the reaction towers, and on the other the nitrous-sulphuric acid from the Gay Lussac tower.

It is stated that the cost of producing acid does not exceed that of the acid made in lead chambers, and that it is even less when the interest on the small capital invested is taken into account. Also that the apparatus has great simplicity of installation and operation. It is applicable to a daily production varying, according to dimensions of towers and number of roasting furnaces, from 1400 to 20,000 pounds or more of acid.

INDEX TO LEADING ARTICLES.

The journals quoted are indicated by initials, and their full titles are given in the opening pages of the Review. Other abbreviations are, Ill=Illustrated; W=Words.

25799. On the Preparation of Carbon Blacks from Natural Gas in America. Godfrey L. Cabot (Sc A S-Oct. 13.) 3400 w.

25800. The Lardarelo Boric Acid Works. (Sc A S-Oct. 13.) 700 w.

*25873. The Electrolytic Production of Chlorine and Soda. Emile Andreoli (E R L-Oct. 5.) 1200 w.

25891. Sodium Silicate and Its Use for Cleansing Cotton Waste, etc. (T-Oct. 15.) 1400 w.

25991. On the Presence in Paper of Residual Chemicals Used in Its Preparation. Robert Irvine and G. Sims Woodhead. (Sc A S-Oct. 20.) 2000 w.

26199. Cellulose and Some of Its More Recent Applications. Charles A. Silberrad (Sc A-Oct. 27.) 1700 w.

26201. The Chemical Pulp Process (Sc A S-Oct. 27.) 1200 w.

†26229. A Method for Determining Calcium Oxide in Quicklime. W. E. Stone and F. C. Scheuch (J A C S-Nov.) 1500 w.

26350. Economic Manufacture of Sulphuric Acid. Ill. (Sc A S-Nov. 3.) 2500 w.

26351. Utilization of Waste Carbonic Acid Gas in Breweries. A. Marcet (Sc A S-Nov. 3.) 1200 w.

†26379. I. On Some New Methods of Obtaining Platinochlorides. II. Probable Existence of a Platinum Subchloride. M. Carey Lea (A J S-Nov.) 1500 w.

26456. Petroleum: Its Products and Their Relation to the Gas Industry. C. H. Evans (A G L J-Nov. 5.) 2200 w.

26473. Monazite.—A Strange Mineral Found in North Carolina (B J C-Nov. 3.) 400 w.

26495. Weathering. William White, Jr. (A M & I W-Nov. 2.) 600 w.

*26498. Chemistry of Iron: Modern Practice. John Parry (I & S-Oct. 27.) 3300 w.

We supply copies of these articles. See introductory.

INDUSTRIAL SOCIOLOGY

Workmen's Diet and Wages.

THE subject named is one of unquestionable importance, and in the *Fortnightly Review* it has been treated from a physiological as well as sociological stand-point, by Thomas Oliver, M. D., who shows by a comparison of the dietaries of former periods and of the present that the toiling classes of Britain have shared in the advance that has been made in the feeding, clothing, and housing of the nation generally. No attempt is apparently made to show that artisans or agricultural laborers have fully and fairly shared in this advance. The main point considered is their diet. The "diminished use of simpler foods and the increased consumption of articles which tickle the palate more than did the plain but wholesome food of our forefathers" is noted. "The tendency of the age is toward refinement in food as in all else. We seek for articles that please the eye, as well as stimulate the palate. People, for example, must have their flour beautifully white; but in order to accomplish this the miller has, by improved machinery, to remove from the grains of wheat the rich nitrogenous cells that lie underneath the bran—that part of the wheat grains in fact which is richest in proteid or nitrogenous material." This is instanced as indicating a widespread change in regard to alimentation of the laboring classes which is in progress in Britain. Tea has been reduced in price, and in the cottar's home "tea with bread and butter, now too frequently replaces the milk and often porridge of past days." The words "too frequently" must be taken as applying to the physiological view of the subject, its economic side, except so far as food is related to muscle and muscular effort represented in useful labor, having been left out of view.

It is asserted that shepherds and hinds in many parts of England are paid less "in kind" than they were; that they therefore have more money to spend; that money has a greater purchasing power than formerly, and that little delicacies and luxuries are now more sought after. This is all the more true of artisans dwelling in cities. Among these a distinct tendency toward "a reduction of coarse food, and a substitution for it of the higher, if not less nutritious articles of diet," is perceptible.

The collection of materials for the purpose of study and comparison of the present dietaries of different parts of the kingdom has been largely effected by correspondence, and much interesting information has been thus got together.

"From his well stocked garden the Scottish agricultural laborer obtains potatoes, green vegetables and fruit. Many of them get their milk either free or at a nominal cost from the farm. Their breakfast is milk and porridge. For dinner they have broth, meat, potatoes, and tea. At 6 P. M. they have porridge and milk, bread and butter, and jam." The cost of living per week in a family the father of which gets 15 shillings per week and the allowances named, and which consists, beside the father, of a wife and five children, is stated to be from 12 to 13 shillings per week, the remainder being required for clothing, etc. "The cottar, practically, can make no provision whatever for sickness or death, unless in a few cases only, where he pays a penny or twopence a week into a burial society. It is when his children grow up and enter service, that he may be able to save a little money."

The wages of Irish agricultural laborers are smaller and their dietary more meager than that of Scottish laborers of the same class. Wages, 5 to 8 shillings per week. So insufficient is his feeding, that when the Irish farm laborer goes to England to work in the harvest, it is not until two or three weeks of more ample diet strengthen him that he can do a full day's work. "Potatoes are still the staple diet of the Irish peasant." This food is extremely deficient in nitrogen. Many Irish laborers live upon Indian meal mixed with white

flour, potatoes, and tea, seldom partaking of animal food.

"When the English agricultural laborer has no children he is able to feed pretty well. He consumes large quantities of fat. He eats largely of bread and cheese. When he has a family it costs him 67 per cent. of his wages for the necessaries of life and house rent. Coal miners are said to feed well, using considerable animal food; and the dietary of the English navvy may compare well with that of the collier. Iron and steel workers work hard, get good wages and substantial food, and the temperate can save something out of their wages." The women who work in the manufactories of white lead are spoken of as about the worst fed laborers in England, their diet being reduced by their necessities almost to the starvation point. In every point of view, their condition is pitiable. Their poorly nourished bodies are ill fitted to resist the poisonous action of the lead, to which many of them fall victims.

While the cotton spinners of Lancashire are stated to be as a class well paid and well fed, they are as a rule not in robust health. In some of the factories where fine spinning is done the air has to be kept too warm and moist for health; and in general the work of cotton spinning is carried on in large, frequently overheated, and at times not too well ventilated rooms. Cotton spinners leave their homes in the early morning, both husband and wife usually working in the same factory. If they have an infant, it is left at a creche, and as "many of them take their food to the mill, it is not until the day's labor is over that the mother picks up her child on the way home, opens the house, kindles the fire and prepares tea." The rent of their house is from 4*s.* to 4*s.* 6*d.* per week. They work 56½ hours per week. Wages not named. Nervous diseases are on the increase among them, especially insanity. Child-bearing is fatal to many of the women. "Standing on their feet all day amid the roar and din of machinery, inhaling an atmosphere overheated, humid, laden with fluff, and redolent with rancid oil, their life's work in time becomes as mechanical as the machinery they tend, and their prospects as cheerless as their work is monotonous."

At Nottingham lace workers labor ten hours a day, and earn 40*s.* a week. Girls earn from 6 to 15*s.* Rents range from 4*s.* 9*d* to 6*s* 3*d.* Except when daughters work they save no money. Their diet is fairly good. Men employed in woolen industries in and around Bradford live pretty well. They work from 10 to 10½ hours per day, earn from 18 to 32*s.* per week, and their house rent ranges from 3*s.* to 4*s.* 6*d.* per week. They are temperate, and saving.

Thus is seen how many of the workers of Great Britain live, what they earn, and what they pay for rents. The question of the effect of diet as related to physical ability to labor is discussed, as are also the questions of wages as related to food, and the best selection of food within the scope of wages which British labor commands.

The Legislation of Fear.

SINCE time and distance, through the aid of steam and electricity, have ceased to be materially obstructive to intercourse between the continents the unity of the human family, notwithstanding national boundaries and race prejudices, is daily increasing. A czar or a great statesman falls sick in almost any part of the world, and we hear daily accounts of his condition as surely, and almost as quickly as we would were he a neighbor citizen living in the next block. If he die we shall have the news in an hour or two. Puck's forty-minute girdle has been stolen by science from the fairies, and the common pulse of humanity beats in unison on opposite sides of the seas. When any voice that has won the right to be heard is now raised in behalf of the oppressed it is heeded almost simultaneously over both hemispheres. When any pen whose power has been proved is wielded on the side of right, it commands not merely a local, limited influence; the field is the civilized world. Among those to whom the world gives such attention is a woman who first won fame as a novelist, and having proved by her powerful delineations of human passion

her keen insight into the springs of human action—having probed to their depths the virtues and vices of existing social conditions—has lately taken place among essayists.

This woman, Ouida, always writes with force. It can hardly be claimed that her advent into this field has added much to the thought pervading current sociological discussion; but it cannot be denied that it has added to the interest of the debate.

In the *Fortnightly Review* (October) in "The Legislation of Fear," she has fearlessly made some startling statements which those who wish to keep in touch with what is going on will feel obliged to read if they do not want to move rearward in the procession. The contention is characteristically set forth in the opening paragraph. Ouida does not leave her readers long in doubt of what she is driving at:

"To any one convinced of what seems to be a supreme truth, that the happiness of humanity can only be secured by the liberty of the individual, the tendency of opinion in Europe in this present year must be a matter of grave anxiety. The liberty of the public is everywhere suffering from the return to reaction of their governments. The excesses of a few are made the excuse for the annoyance and restriction of the many. Legislation by fear is everywhere replacing legislation by justice, and is likely to continue to do so. The only statesman who has spoken of anarchy in any kind of philosophic spirit is Lord Rosebery, who called it 'that strange sect of which we know so little.' All other political speakers have treated it only with blind abuse. In truth we do know almost nothing of it; we do not know even who are its high priests and guiding spirits. We know that it is a secret society, and we know that secret societies have always had, in all climes and for all races, the most singular and irresistible fascination. To meet it ordinary society has only its stupid brutal police system; its armies of spies, who as the journey of Casserio from Cette to Lyons proves, are hopelessly useless, even when they are truthful."

That "Legislation by fear is everywhere replacing legislation by justice," is made plausible, if not proved by a long array of facts, and incidentally a comparison between anarchism and nihilism is made which is favorable to the latter:

"It is impossible not to recognize great qualities allied to great cruelties in anarchists and nihilists, and, in the former, to great follies. When we remember the ghastly punishment of even the slightest offences in Russia, yet see continually that some one is found who dares place on the Tsar's dressing table or writing table a skull, a threatening letter, a dagger, or some other emblem and menace of death; that to do this access is obtained into the most private and carefully guarded apartments of imperial palaces; that who it is that does this can never be ascertained (*i. e.*, there is no traitor who betrays the secret), and that the most elaborate vigilance which terror can devise and absolutism can command is impotent to trace the manner in which entrance is effected, we must admit that no common organization can be at work, and that no common qualities must exist in those affiliated to it. There is no doubt that anarchism is a much more vulgar and much more guilty creed than nihilism. The latter has the reason of its being in the most brutal government that the world holds; it lives in hell and only strives to escape from that hell, and liberate from it its fellows. Anarchy, with no such excuse, strikes alike at the good and the bad; strikes indeed at the good by preference."

The array of facts that follow, compiled from recent annals, indicate the trend of public opinion in Europe as away from individual liberty. A few of those most briefly stated will be quoted.

"A youth of twenty-one was in the second week of July condemned at Florence to fifteen months' imprisonment for having called the *pretore* of a petty court and his subordinate *vigliachi* (scoundrels); an expression so appropriate to the officials of these vicious and corrupt little tribunals that it was unpardonable. If at the end of the fifteen months the lad comes out of prison at war with society, a second Caserio, a second Vaillant, whose will be the fault?

"A young lady of good family saved a little dog from the guards in Paris and when she had seen it safely up its staircase turned in righteous indignation on the men. 'Are you not ashamed to persecute innocent little animals?' she said to them. 'You would be better employed in catching thieves.' This just remark so infuriated them, as a similar observation did the Florentine *pretore*, that they seized her, cuffed her, dragged her along under repeated blows, tearing some of her clothes off her back, and, reaching the police station, locked her up with the low riff-raff of the streets.

"In July at Ravenna eight young lads were flung into prison for singing the Hymn of labor.

"Yet more absurd still. In Florence a band of young men were arrested for singing the choruses from the *Prophete*, which sounded revolutionary to the ears of the police. At the same time, the indulgence shown to the crimes of the police is boundless."

A glowing tribute is paid to the late President of France.

"Carnot lies dead in the Pantheon, and Liberty lies dying in the world. His tender and unselfish heart would have ached with an impersonal sorrow, greater even than his grief for those he loved, could he have known that his death would have been made an excuse for intemperate authority and pusillanimous power to gag the lips and chain the strength of nations."

This essay appeals perhaps more to heart than to reason, but it appeals to reason also; and as to its allegations of police brutality, some American cities, New York in particular, will be prepared to believe almost anything.

Possibilities of an Anglo-American Re-Union.

A SYMPOSIUM upon this subject appears in the *North American Review* for November. Capt. Alfred T. Mahan, U. S. N., and Capt. Lord Charles Beresford, R. N., both give opinions unfavorable to the practicability of an alliance at the present time as has been proposed.

Capt. Mahan opens the discussion by making a distinction between the words "kinship" and "alliance." "The former represents a natural relation, the latter one purely conventional—even though it may result from the feelings, mutual interests, and the sense of duty attendant upon the other. In its very etymology, accordingly is found implied a sense of restraint, of an artificial bond, that may prove a source not only of strength, but of irksomeness as well. Its analogue is the marriage tie —the strongest doubtless of all bonds, when it realizes in the particular case the supreme affection of which our human nature is capable; but likewise, as daily experience shows, the most fretting when, through original mistake or unworthy motive, love fails, and obligation alone remains."

The growth of mutual kindly feelings between Great Britain and the United States during these latter years is regarded as "a sure evidence that a common tongue and common descent are making themselves felt, and breaking down barriers of estrangement which have too long separated men of the same blood."

The geographical position of the two countries which so severs them from existing rivals as to give exemption from "the burden of great land armies" is a condition favorable to the ultimate reunion.

"To Great Britain and the United States, if they rightly estimate the part they may play in the great drama of human progress, is intrusted a maritime interest, in the broadest sense of the word, which demands, as one of the conditions of its exercise and its safety the organized force adequate to control the general course of events at sea; to maintain, if necessity arise, not arbitrarily, but as those in whom interest and power alike justify the claim to do so, the laws that shall regulate maritime warfare. With such strong determining conditions combining to converge the two nations into the same highway, and with the visible dawn of the day when this impulse begins to find expression in act, the question naturally arises: What should be the immediate course to be fa-

vored by those who hail the growing light, and would gladly hasten the perfect day?" And it is here that an obstacle presents itself in the lack of experience which cannot be had in advance of facts not yet developed. "Let each nation be educated to realize the length and breadth of its own interest in the sea; when that is done the identity of those interests will become apparent."

This development will "follow the not far distant day when the United States people must again betake themselves to the sea, and to external action as did their forefathers alike in their old home and in the new."

Capt. Mahan thinks that however desirable it may appear, such an alliance could not be effected at the present time. The requisite conditions for cordial agreement do not yet exist.

"Is it not clear that maritime commerce occupies, to the power of a maritime state, the precise nourishing function that the communications of an army supply to the army? Blows at commerce are blows at the communications of the state; they intercept its nourishment, they starve its life, they cut the roots of its power, the sinews of its war. While war remains a factor, a sad but inevitable factor, of our history, it is a fond hope that commerce can be exempt from its operations, because in very truth blows against it are the most deadly that can be struck, nor is there any other among the proposed uses of a navy, as for instance the bombardment of seaport towns, which is not at once more cruel and less scientific. Blockade, such as that enforced by the United States Navy during the civil war, is evidently only a special phase of commerce-destroying; yet how immense—nay, decisive—its results."

Lord Beresford quotes Mr. Carnegie (*North Am. Review*, June, '93) and agrees with the following contentions in support of an alliance: "1. The natural sympathy and brotherhood between two nations sprung from one race. 2. The quick, comfortable, and efficient line of communication between the two countries. 3. The excellence of the telegraphic communication. 4. The easy possibility of confederation between two races similar in character, ideas, and sentiments." But the suggestion of "alteration in the fiscal policy of the two countries" made by Mr. Carnegie is pronounced "a complete impossibility." Neither does Lord Beresford agree with a statement made by Mr. Carnegie "that the individual parts of the empire hail such a union with enthusiasm."

"The United Kingdom must be spoken of as a whole, and it is impossible to talk of England, Ireland, Scotland, and Wales as semi-independent states. The United Kingdom must remain a whole, if it is to remain at all. If split up it could not retain that force and character which have enabled it to build up and govern the greatest empire the world has ever seen." The different impediments to a reunion as enumerated by Mr. Carnegie are gone over seriatim. Finally Lord Beresford makes a suggestion claimed to be more practical than those hitherto presented, to wit: "An alliance between Great Britain and the United States for the protection of those commercial properties in which both are equally interested."

"What is coming in the near future, who can tell? But will anybody deny that an alliance such as is advocated here would do much to insure the continued peace and prosperity, not only of the Anglo-Saxon race, but of the entire civilized world?"

A Proposed Series of International Expositions.

AN attempt now on foot to draw the nations of the western hemisphere into closer communication and more intimate commercial relations is gaining favor and assistance from those it is intended to benefit—such as are engaged in or who desire to extend American commerce in Central and South America. A scheme for a series of international expositions to be held in South American capitals (the first to be held in the City of Mexico) proposed by *Dixie*, a journal devoted to the industrial interests of the South, has received marked encouragement from manufacturers in different parts of the

United States. A letter written by Mr. T. P. Egan, a widely known and influential western manufacturer, and printed in the Cincinnati *Commercial Gazette*, indicates the spirit with which this proposition has been received. An initial movement has been made to hold a convention of manufacturers to consider the subject, and to take action toward carrying out *Dixie's* proposal. Mr. Egan's letter is an argument favoring first, the holding of the expositions, and secondly, favoring Cincinnati as the place for holding the convention.

"The severe conditions under which our manufacturers have labored for the past twelve months would have been lightened to a considerable extent had they in the past taken the pains that European manufacturers have taken to establish trade relations with Mexico, Central and South America. The Europeans have devoted every energy to ingratiate themselves with the buyers in these countries, while our manufacturers have been satisfied with very indifferent efforts.

"The J. A. Fay & Egan Company, The Lodge & Davis Machine Tool Company and several others of the leading manufacturers of this city have been sending Spanish-speaking representatives for the past three years to these countries. They have invariably secured large and remunerative orders, proving conclusively that the business is there and can be obtained.

"It is true that the rapid development of our own country has heretofore called for nearly the entire output of our manufacturing establishments, but the recent past, and in fact the present condition of the machinery trade, prove that our foundries and machine shops have a greater capacity than domestic consumption demands, and our manufacturers are on an active outlook for new trade fields. It has not been a lack of enterprise, but a lack of necessity, that has until now deterred their efforts to win the trade of our sister Republics.

"European machinery and equipment of a very inferior grade is being sold in large quantities to the miners, manufacturers and developers of the Spanish-American Republics. Europeans are getting good prices for this machinery, prices that our manufacturers would jump at; but as matters stand, we have no means of getting at this trade."

The proposition made by *Dixie*, comprised the restoration of reciprocity treaties rescinded by the last congress, as very little business can be done unless these treaties are restored. "The plan upon which these expositions could be held to mutual advantage would be that the government of these different countries would make an elaborate display of their mineral and other resources, together with a complete exhibit of all interesting features of their country, the manufacturers of the United States to coöperate with the different governments by making a magnificent display of machinery and other manufactured products adaptable to the needs of the different countries."

It seems possible that the convention will be held at an early day, and Cincinnati seems a favorable point to hold it, being centrally situated in a large manufacturing district, which can be easily reached not only by southern delegates, but from all parts of the country. The movement is growing in importance, and its issue will be watched for with interest on both sides of the Atlantic.

Labor Misrepresentations.

OF "Popular and Injurious Class and Labor Misrepresentations," or what he is pleased to characterize as such, an anonymous writer in *The Westminster Review*, has something to say in the October number. A defense is made of the "wealthy and upper classes" from the charge that they are "selfish robbers whose luxuries have been obtained by defrauding the poor." The custom of holding up the improvements achieved, "as rights acquired solely by force of organizations of the workers against their employers" is denounced as not warranted by facts. If it be justified, then, obviously, "the employers must previously have peen oppressing their men for their (the men's) own benefit, and amassing wealth which is now divided amongst the men. "How far is this the real

explanation of the admitted very great change for the better in their condition?"

Under conditions existing a century ago, low wages prevailed, "but low wages to hand labor would not result in cheap buildings or goods." Small buildings must have cost proportionally very much more than the better houses of to-day." Clothing woven by hand could only be relatively dear and scarce." "Food has been cheapened during the same period by the construction of railways and steamboats, and the invention of the telegraph and telephone, which enable practically limitless supplies to be brought from the ends of the earth to counteract scarcity in any quarter."

While this is true, it is also true that wages have been augmented—in many cases doubled—while hours of labor have been reduced. How then has labor been robbed? And who are the robbers, if any exist? The proposition is rejected as absurd, and this kind of talk is denounced as having no reasonable basis, and as therefore hurtful to the cause of labor.

INDEX TO LEADING ARTICLES

The journals quoted are indicated by initials, and their full titles are given in the opening pages of the Review. Other abbreviations are, Ill=Illustrated; W=Words.

*25570. Profit Sharing in the Coal and Iron Industries. Editorial (I C T-Sept. 21.) 1600 w.

25590. The Liability of Labor Unions for Damages—The Lucke Case. R. W. Raymond (E M J-Sept. 29.) 500 w.

25591. Bimetallism vs. Silver Monometallism (E M J-Sept. 29.) 1500 w.

25618. Governor McKinley Compares the New and the Old Tariff Laws (B I S-Oct. 3.) 1500 w.

*25758. The Social Improvement of European Labor.—Laudable Efforts of Continental Employers. E. R. L. Gould (E Mag-Dec.) 3500 w.

25811. The Jenkins Strike Injunction Case (R R-Oct. 6.) 4800 w.

25814. Theory and Practice. Editorial (R R-Oct. 6.) 1100 w.

†25824. Popular and Injurious Class and Labor Misrepresentations (W R-Oct.) 2500 w.

25903. A Remedy for Railway Strikes. Robert Larmour (R R-Oct. 13.) 2200 w.

†25963. The Work of the Beer Money. John Rae (C R-Oct.) 12000 w.

†25964. French Prisons and Their Inmates. Edmund R. Spearman (C R-Oct.) 6000 w.

†25974. Our Workmen's Diet and Wages. Thomas Oliver (F R-Oct.) 6400 w.

25981. Compulsory Arbitration and Prices Fixed by Law. (Extract.) Carroll D. Wright (Ir Age-Oct. 18.) 900 w.

26147. The Arbitration Question (B D-Oct. 20.) 900 w.

*26161. Labor vs. Machinery (M-Oct. 15.) 1400 w.

*26210. The Recent Strike at Pullman. Editorial (E-Oct. 19.) 2700 w.

†26263. Possibilities of an Anglo-American Reunion. I. Alfred T. Mahan. II. Charles Beresford (N A R-Nov.) 9000 w.

†26268. The Legislation of Fear Ouida (F R-Oct.) 4500 w.

*26281. Guilds and Unions in the Middle Ages (I C B-Oct. 19.) 2500 w.

26290 Marketing the Surplus. Editorial (E M J-Oct. 27.) 1000 w.

26303. Extracts from the Address of Thomas B. Reed at Cooper Union (B I S-Oct. 27.) 2000 w.

26315. American Manufacturers.—Cincinnati the Place for the Forthcoming Convention of a Great Industry. T. P. Egan (C C G-Oct. 16.) 600 w.

*26324. The Wage Earners' Loss During the Depression. Samuel W. Dike (F-Nov.) 4800 w.

*26325. Facts Touching a Revival of Business (F-Nov.) 2800 w.

26344. The Institute of Sociology (ScA-Nov. 3.) 800 w.

26387. Convicts on the Public Roads. Views of Governor Northen (M R-Nov. 2.) 1000 w.

26388. Greater Trade with Mexico (M R-Nov. 2.) 1300 w.

26423.—$1. The Economic Function of Woman. E. T. Devine (An A A-Nov.) 5400 w.

*26431. Labor Saving Machinery (Mill-Oct.) 1300 w.

*26440. Machinery and Labor. Editorial (E-Oct. 26) 1800 w.

*26441. The Scotch Coal-Miners' Strike. Editorial (E-Oct. 20.) 1800 w.

*26508. Labor Troubles at the Plymouth Gas-Works.—Attempts to Wreck Plant (J G L-Oct. 23.) 1600 w.

†26532. Immigration and the Land Question. C. J. Buell (A-Nov.) 3300 w.

26619. The Foreign Trade of Japan and the Nicaragua Canal (M R-Nov. 9.) 1500 w.

We supply copies of these articles. See introductory.

MARINE ENGINEERING

An Aluminum Torpedo Boat.

"TEN tons with steam up and coal in the bunkers; twenty and a half knots speed; 300-horse-power." *The Engineer* (London, Oct. 5) says that "ten years ago—perhaps five years ago—the man who suggested the possibility of producing a boat which could live in a sea and satisfy the conditions embodied in the first lines above, would have been regarded as a lunatic by those who had not watched the progress of events." On September 30, on the Thames river all these conditions were fulfilled by Mr. Yarrow in an aluminum torpedo boat, the largest structure of any kind yet built of that metal. Two other aluminum boats have been previously built, one for use in arctic exploration and a small yacht. A description with an illustration of the new torpedo boat informs us that she is 60 feet long, and 9 feet 3 inches beam. Her width of beam—9 inches more than other second-class torpedo boats that have preceded her, is considered as an "improvement in many respects." It appears that for this and analogous purposes in marine engineering a new field has been opened for the use of aluminum, which may have an important influence upon the future of this metal in the industries of the world. The lighter anything which has to be hoisted to or lowered from the deck of a ship can be made, the better it is, provided no other useful quality be sacrificed, and the lighter a ship's boat for any purpose can be made, all other things being equal, the higher the speed that can be attained with it. English battle-ships carry as part of their regular equipment a number of these boats; and if it prove that aluminum is fitted in all respects as a material for their construction, a third advantage gained in the reduction of weight thus secured (as these boats are carried high up on deck) is that they will affect the stability of the ship less than heavier boats.

"Comparatively little has been known about aluminum as a structural material, and before adopting it Messrs. Yarrow and Co. carried out a series of elaborate experiments on the metal to obtain information. The great and uniform success of this firm in all their ventures is largely due to the elaborate system of experimenting carried out at Poplar. The trials of aluminum referred to its stiffness, best working temperature, corrosion, etc. It was found, in the first place, necessary to alloy the metal, by which its tensile strength was raised from 9 tons per square inch to about 18 tons. The alloy is mainly 6 per cent. of copper. As regards stiffness, etc., a general result was arrived at. All scantlings were increased 25 per cent. over that allowed for steel, and as aluminum weighs about one-third of steel, it follows that a reduction of about one-half was effected in the weight of the hull, which was reduced from about four tons for steel to about two tons for aluminum.

"In order to arrive at some precise information concerning corrosion, two aluminum plates were accurately weighed, and then secured on the sides of a wooden coppered sailing ship, the copper being removed and replaced by the aluminum. The ship made a voyage around the world, then the aluminum plates were removed, weighed, and found to have suffered no appreciable loss. The great foes to aluminum are alkalies which attack it powerfully, and heat. It fuses at a moderate heat, and loses much of its strength at comparatively low temperatures. In the case of a torpedo boat there is no trouble incurred in avoiding both sources of risk. No plates or angles were touched by the fire; everything was bent cold. The frames are a little closer together than they would be if of steel, the extra cost of material in the use of this particular boat being £1000 as compared with that of steel. In turn there is a saving of about two tons in weight and a gain of about

3½ knots in speed over vessels of the same class and dimensions in the British navy which steam under the like conditions at 17 knots.

"The boat is built in the usual way and triple-riveted with aluminum rivets. Her machinery consists of a set of triple-expansion engines, driving an aluminum bronze propeller at 580 to 600 revolutions per minute. These engines are balanced without bob weights, on Mr. Yarrow's principle, at two points only, the balance weights being fitted at properly calculated angles to the cranks. The boiler is of the ordinary Yarrow water-tube type."

After presenting the record of the official trial of the boat, *The Engineer* hazards the opinion that this boat is in every way a marked success. If further experience sustain this view a good many aluminum boats of various kinds will probably be built during the next decade.

"Beyond all question Mr. Yarrow has achieved a remarkable success. Many wise men shook their heads when he suggested the use of aluminum, and did not hesitate to say he was courting failure. The result, however, has more than justified him; he has succeeded in producing the best torpedo boat of the size that has ever been built. It now remains for the makers of aluminum to improve their processes and cheapen their material, so that the use of the new metal may be widely extended."

A New South African Liner.

FEW Americans have the slightest idea of the kind and amount of traffic now existing between English ports and the South African colonies. A description of the new South African liner *Norman* given in *Transport* (Oct. 19), will afford a more realizing impression of the tendencies of this traffic than would otherwise be obtained except by those who have had opportunity for personal observation.

"The leading dimensions of the vessel are: Length 490 feet between perpendiculars; breadth, molded, 53 feet; depth, 37 feet 6 inches; and her gross tonnage is 7392 tons. She is constructed of steel, and is fitted with twin screws like five others of the Union Company's fleet. This arrangement will contribute much to the safety of passengers, as in the case of one set of engines becoming disabled, the other set of engines will still be able to maintain a fair speed and propel the ship on her voyage. She is fitted with two sets of triple expansion engines, expected to develop great power and high speed, and at the same time she is designed for carrying a large cargo, or considerable numbers of troops. Large numbers of passengers are provided for in each class. The first and second-class accommodation is amidships, thus insuring comfort, quiet, and ample ventilation, the third class being located on the main deck forward; and in this connection it may be mentioned that the *Norman* is capable of berthing 160 third-class passengers surrounding their saloon; but if there should be a greater number offering at any time, equally good quarters can be provided for them.

"The first-class saloon provides seating accommodations for 150 passengers, and is situated on the upper deck. The panelling has been carried out in wainscot oak, tastefully carved and relieved in gold. The apartment is surmounted with a magnificent dome, consisting of a semi-circular vault terminated by hemispherical ends filled with stained glass, into the design of which shells and marine vegetation enter largely, and containing symbolical representations of agriculture, commerce, manufactures, painting, sculpture, and letters, the whole forming a very carefully considered decorative scheme. The second-class saloon is situated on the main deck aft, and furnishes seating accommodations for 100 persons. The drawing-room and library, which is placed at the forward end of the deck-house on the promenade deck, is about 36 feet long by 24 feet broad, and upwards of 10 feet in height. The general decoration is carried out in elaborately designed satin-wood panels. The smoking rooms, both for first and second-class passengers, are very luxurious. The *Norman* is constructed with poop and forecastle, and has central deck-houses containing dining-saloons, etc., over which is an exceptionally fine promenade deck. Electric

light and refrigerating plant has been installed throughout, and there are refrigerating engines and machinery. Cold chambers are provided for ship's stores, as well as for the conveyance of fruit and other perishable goods. The vessel is divided into water-tight compartments in accordance with the recommendations of the parliamentary bulkhead committee, thus insuring the maximum safety of passengers in case of accident."

It must be understood that this fine steamship is only one of a magnificent fleet of the Union Steamship Co. which conveys a stream of civilization to and fro between England and a country that a century ago, was peopled by barbarians. The time set for the new ship to sail on her first voyage was the 10th Nov. She is to start on her return trip on the 19th Dec.

The British Shipbuilding Industry.

UPON returns recently issued from Lloyds Registry, *Engineering* (London) bases an editorial opinion that the shipbuilding industry has a depressing outlook for the coming winter. The work on hand in the ship-yards is less than at any previous time in the year, although the output up to the present time has been very much below the average. Neither are there visible any immediate cheering signs of a revival.

"There is scarcely any need to inquire into the reason, for it is notorious that the board of trade, at the bidding of the political agitator, has raised so many restrictions in respect of ships flying the Union Jack, as to immensely handicap them in their competition with foreign ships. In fact, the foreign flag is a protection to the ship against many pettifogging regulations which do real good to few, and injure a great industry. That they do little good is evidenced by the fact that foreign ships can easily get British crews, and that injury is done is proved by the large number of vessels sold to foreigners, the diminution in vessel building, and the large number of vessels building for foreigners in British yards. The proportion is usually a fourth to a fifth, even in times of activity in the yards, and at present nearly 15 per cent. are for foreigners, so that it may be accepted that the influences at work are not so strongly operative in the case of the foreigner. Low freights of course, have much to do with the matter, but, that, all things being equal, would affect foreign in the same ratio as British tonnage. They do not, because all things are not equal."

The falling off of work since the beginning of the year has been very marked, and since July 1, the decrease has been 65,000 tons. Counting from April 1, the falling off has been 72,000 tons. The steady diminution in the proportion of sailing tonnage to the total, is one of the notable features of the statistics of the trade. "The tonnage being started is only about half what it was in April, and as the total tonnage is very much less now than it was then, the state of the trade is very much worse than it was at the spring of the year." A table of the apportionment of the work among the various shipyards is given. Both colonial and foreign orders for ships, especially for sailing vessels are unprecedentedly light.

Naval Construction in France.

UNDER the title "The Decennial Programme for Naval Construction in France," *The Engineer* (London) discusses editorially the programme of construction set forth by the French admiralty board at the end of 1891, which included a list of 82 vessels, all of which were to be built before the expiration of the year 1901. The list of these vessels, showing their kind and class, is given. The cost of their construction is estimated as $145,200,000. The point made is that this programme, begun with apparent vigor, has been more and more departed from, and that it is even likely to be abandoned.

Once the decennial programme of 1891 was voted in parliament, the admiralty board deemed it necessary to begin in good time the eighty-two ships, in order that they might be completed at the end of the year 1901. Now, for the first three years—1892, 1893, and 1894—the number laid down should have amounted to 29, viz.: sea-going battleships, 6; first-class cruisers, sheathed, 2; unsheathed, 1; second-class cruis-

ers, sheathed, 2; unsheathed, 4; third-class cruisers, sheathed, 4; unsheathed, 3; torpedo-depot ships, 2; floating workshops, 1; torpedo-gunboat, 1; gunboats, 3; total, 29.

A close review of what has been done during the time that has elapsed since its promulgation towards carrying out this programme is then presented, all the vessels begun in the different years being named, showing that year by year, beginning with the year 1891, the departure from the original scheme has been widening, and the statement is made that at the end of 1894, nine of the projected ships will not have materialized.

Sailing Vessels on the Hudson River.

THE gradual diminution in the number of sailing vessels on the Hudson river and the corresponding increase in the number of steam craft is made the subject of editorial comment in the *American Shipbuilder*. Only a few years ago steam craft except for passenger traffic, were the exceptions; now they rule, and the picturesque sight which the river once displayed with its multitudes of sails has probably forever departed. The time is recalled when the passenger traffic up and down the river was confined to packet sloops which were "beautifully modeled vessels of from 75 to 100 tons burden, built with a view to speed, carrying capacity and comfort. The sides of some were adorned with bead work and others with different colored woods inlaid. They were all handsomely painted. The canvas was snowy white and the masts were scraped as often as a speck of dirt appeared. The cabins were finished in mahogany and other fancy woods, and were decorated as beautifully as the taste of the times permitted."

Other interesting reminiscences are recalled. The colonists were compelled by law to use no other than the sloop brig. The reason assigned for this is jealousy of colonial enterprise on the part of the mother country, and an endeavor to restrict the colonist merchants to small coasting vessels, "but the American spirit kept the letter of the law by building nothing but sloops, while it captured the foreign trade by building them large and swift enough to compete with the best vessels constructed by Europeans. Afterward, when taxes were levied on colonial trade, the people were as anxious to conceal their true condition as the owners of personal property are in these days. Thus a report made by the Governor of Rhode Island to the Lords of the Committee of Colonies said that 'We have no shipping belonging to the colony, but only a few sloops.'"

When a custom house was established at Newport and the Lords of the Committee of Colonies made inquiries, they found that *few* meant over a hundred, and that "Rhode Island sloops could carry more cargo than British brigs." An anecdote is told of a "Hingham sloop of forty tons measurement which sailed out of Boston harbor bound for Canton. . . . The captain of the sloop did not know that the shortest route to the east lay one thousand miles south of the Cape of Good Hope. At Cape Town harbor where the captain put in for supplies, a number of English merchantmen were found. They thought it would never do to allow a Yankee to get a taste of the profitable East India trade, and bought the sloop's cargo, which consisted of ginseng, paying two pounds of tea for one pound of root. The sloop returned and sold the tea at an enormous profit. The captain of the Albany sloop *Experiment*, hearing of the great price the Britishers had paid for ginseng, concluded that the Chinese would give more than the British, and on December 15th, this sloop, measuring 84 tons, with a crew of seven men and two boys sailed past Sandy Hook for Canton and covered the 15,000 miles of salt water between New York and that port." The enterprise which marked the history of the early American marine is well exemplified in these instances. Were existing obstacles removed this same enterprise would be again manifested.

"SEABOARD," quoting the *Journal of Commerce and Commercial Bulletin*, endorses the opinion that the present Atlantic liner has very nearly approached its maximum speed. The "shrinkage of time is now

numbered by minutes. "Reference is made to Col. Elsdale's opinion given in the *Contemporary Review* some six months ago. "He pointed out that with the increase of propulsive power on steamships, extra resistance is piled up to meet and swallow it up. The head resistance figures but little, it is the surface or skin friction that accounts for much the larger part of the total resistance to a vessel's motion through the water." He thinks it will be found that a smooth surface of iron or steel is about the worst which we can give to our ships, regarding this surface as possessing maximum adhesion for water among materials available for shipbuilding; and he apparently looks for the discovery of some substance that being applied to ships' bottoms will reduce this skin friction, intimating that it may possibly be applied in a manner resembling the scales of a fish. Scales of paper or of ramie fibers were suggested as possibly being suitable for for this purpose. The increase of propulsive power, by the use of steam at two or three times the pressure now usual," and the transformation of its energy into electricity without the waste incidental to rotary motion are also regarded as on the eve of accomplishment. At all events it is quite evident that the limit of speed for vessels of iron, propelled by steam-engines and propeller screws will not be much lowered from present records.

INDEX TO LEADING ARTICLES.

The journals quoted are indicated by initials, and their full titles are given in the opening pages of the Review. Other abbreviations are, Ill=Illustrated; W=Words.

*25269. The Decennial Programme for Naval Construction in France (Eng L-Sept. 14.) 4000 w.

*25786. Feed-Water Heaters: Influence of Circulation on Economy. Ill. (S L-Oct.) 700 w.

25801. Boat with Propelling Turbine. Ill. (Sc A S-Oct. 13.) 900 w.

25804. Atlantic Coast Towing.—A Trip on an Ocean Tug. Ill. (Sea-Oct. 11.) 1800 w.

25857. Sailing Vessels. Editorial (Am S-Oct. 11.) 700 w.

*25916. Aluminum in Torpedo-Boat Construction. Editorial (E-Oct. 5.) 1000 w.

*25930. An Aluminum Torpedo Boat. Ill. (Eng L-Oct. 5.) 1300 w.

*25931. Chinese War Ships at the Battle of Yalu. Ill. (Eng L-Oct. 5.) 1600 w.

*26053. The Dover and Calais Service (E-Oct. 12.) 1100 w.

*26062. The Port of Grimsby. Ill. (Tr-Oct. 12.) 2200 w.

*26150. Development of Steamships in the Nineteenth Century. Ill. Uriel Sebree (Ch-Nov.) 3800 w.

26178. A Maritime Nation. George. E. Belknap (Sea-Oct. 25.) 800 w.

26205. Great Lakes to the Gulf.—Interior Deep Water Navigation (M R-Oct. 26.) 2000 w.

*26211. The Shipbuilding Industry. Editorial (E-Oct. 19.) 1700 w.

*26306. The New Port of Bizerta (Tr-Oct. 19.) 1200 w.

*26316. The Manchester Ship Canal.—Report to the Board of Trade (B T J-Oct.) 1500 w.

*26334. A New South African Liner.—The Norman (Tr-Oct. 19.) 600 w.

26383. "The Future of Steamship Speed" (Sea-Nov. 1.) 900 w.

26395. The New Waterway to Rotterdam. Ill. (W. Gustav Triest (E N-Nov. 1.) 7000 w.

26458. Preliminary or Dock Trials of a Battle-ship at San Francisco. Ill. G. W. Dickie (M A-Nov.) 1800 w.

*26537. The Growth of Steam Navigation. Thomas Sutherland (I C T-Oct. 26.) 2800 w.

†26559. A Practical and Easy Method for Determining or Comparing the Free-Board. Ill. A. Bod (J F I-Nov.) 4500 w.

26562. The Practical Working of the "Chicago's" Machinery and Boilers. Ill. (Ir Age-Nov. 8.) 3600 w.

26564. The American Line Steamer "St. Louis." Ill. (Am S-Nov. 8.) 1300 w.

26616. Our Greatest American Steamship.—The St. Louis. Ill. (Sea-Nov. 8.) 2500 w.

*26549. Shipbuilding in Germany (F'y-Oct. 19) 1200 w.

*26650. The S. S. Nineveh of the "Aberdeen Line" to Australia (F'y-Oct. 26.) 1000 w.

*26651. The Seamen's Union.—How the Money was Spent (F'y-Oct. 26.) 1000 w.

Serials.

16636. Marine Engine Design (M W-Began Oct. 6, 1893—16 parts to date—30 cts. each).

21969. The Shark and the Sailor. A. Ewbank (I E-Began April 14—21 parts to date—45 cts. each.

26091. Some Points in Modern Marine Engine Practice (I & I-Began Oct. 12—3 parts to date—30 cts. each).

26182. Development and Construction of the Marine Boiler. Ill. (M W-Began Oct. 19—1 part to date—30 cts).

We supply copies of these articles. See introductory.

MECHANICAL ENGINEERING

American Machine Tools.

AN article written by Prof. John E. Sweet and printed in the *American Machinist* some months ago, charged a boastful character upon American mechanical engineers; and an attempt to sustain the contention was made by a citation of some of the things done in English and European countries regarded as fine work and difficult to perform. There seemed in this an implication that American mechanics had not much reason to estimate themselves as superior to foreign mechanics if they were even equal. A considerable discussion was thus aroused. It was denied by some that Americans are unduly boastful. It was claimed by others that they had good grounds for supporting the claim of superiority over foreign mechanics. By others it was held that a dispute over such a question is futile and foolish. Notwithstanding this assertion, in the course of the debate many instructive exemplifications of the skill attained in mechanic arts both in America and in foreign lands have been drawn out.

Some of these are contained in an article by T. F. Haggerty in the *Illustrated Carpenter and Builder* (London). Having traveled extensively in Europe and Australian colonies, he asserts that Prof. Sweet's charge of boasting against Americans is only a reiteration of what he hears everywhere abroad. What is called boasting is only a defense of American institutions and industries against those who decry them, except in the case of politicians to whose utterances when examples of offensive boasting are cited, they can usually be traced. This "brag" does not originate with mechanics who are as ready to give credit to foreign merit in workmanship as they are to claim it for their own productions.

In the matter of sawing lumber Prof. Sweet charged that it is better done, and with less waste abroad than in the United States, and Mr. Haggerty replies:

"This would be valuable information to our lumbermen, if they could only know how it is done. Less waste of lumber, no doubt, but with great waste of time; time is the most important item of value, and where material is plentiful then material is wasted and time saved; this is the cause of the success of American workmen. They weigh all the elements entering into any problem, and figure on how much time and money will be saved. The average output of one bandsaw mill I could name, per ten hours' time, is 125,000 feet, board measure, of pine lumber."

Prof. Sweet charged that "in nearly all countries except England iron casting is a fine art" compared with this industry in the United States.

"The facts are just the other way as was shown at the Centennial Exposition at Philadelphia. The kind of castings is not here stated, yet I can say without fear of successful contradiction that the American cooking and heating stoves are works of art such as are not made in Europe; such fine castings as are made in our household hardware of all kinds are unknown to Europeans. If there are such artistic iron-molders in Europe, how is it that none of them show up in the large number of molders that emigrate to America? Is it not a fact that European mechanics in this branch have to receive instruction in our shops before they can get journeyman's wages?"

Prof. Sweet charged that "a better built Corliss engine than was ever built in this country was exhibited at the Paris exhibition."

"If we only knew what was meant by 'better built,' we might be able to determine the difference. Probably highly-finished parts are meant; if so, we could take that same engine, finish it all over and nickel-plate it if it was required. We have seen such engines on exhibition in America. The fact that the French put such fine finish on a Yankee engine leaves them nothing to boast of. Perseverance and emery on a stick, in the hands of a

good workman, produce a good finish, but it requires a different order of talent to invent a new type of engine."

Prof. Sweet credits Europe with machine tools better designed, with better material and better workmanship than the American. "If he has seen any such they were as he says *on exhibition*, and no doubt from American designs."

Prof. Sweet spoke of the making of a "steel turret head 6" thick and 10" diameter, boring seven or more holes through it and hardening the thing as hard as fire and water will make it"; and the general tenor of his remarks leaves it properly to be inferred that he thought this a difficult piece of work, and one that would not be done as well in America as in Europe. Mr. Haggerty vigorously denies this implication.

"I can see nothing difficult in that, and I can safely say that I could go into any ordinary machine shop having proper facilities and get an estimate on any number of them to be delivered in a given time. As this example is given to show how proficient the English, or Germans, are in steel manipulation and risky feats of tempering, I will present an example of American skill in that line as an offset. In American tool manufactories, where there are a large number of parts to be forged, from the smallest scissors blank to the largest-sized tinsmith's bench shears, no matter what the first cost of the dies may be, or how long it takes to make them—provided they will do the work required—they are ordered without delay. After the largest sized blank of a bench shears, say 36 inches long, is struck up between dies, there is a thin burr left around the die, which requires to be trimmed off close to the main body. Imagine a long female die, with a punch to match it, requiring over 200 pounds of tool steel; keep in mind that this is not an iron die with steel welded on the face, such as is used in Europe. It is now required to finish and fit this pair of trimming dies, and temper them 'as hard as fire and water will make them,' and to draw the temper to the required degree of hardness. I have seen a pair of dies thus manipulated. When finished, the male die was laid back down, on a planer bed, and the female die was placed over it to about the depth required when in use, the four corners of the female die being held to a horizontal balance. When thus connected, water was thrown into the top or female die and not one drop ran through between the upper and lower dies. It will be asked how this set of dies was hardened and drawn to temper without twisting or shrinking. I would answer that nothing is left to blind chance in a shop or factory where perfection is the aim, and in this and other instances of a similar kind, the risk of cracking the female die being great, provision is made for subjecting only the cutting edge to the chilling influence of the water, leaving the main body nearly soft. The man who made that set of dies and tempered them would regard it an easy task to make and temper the steel turret."

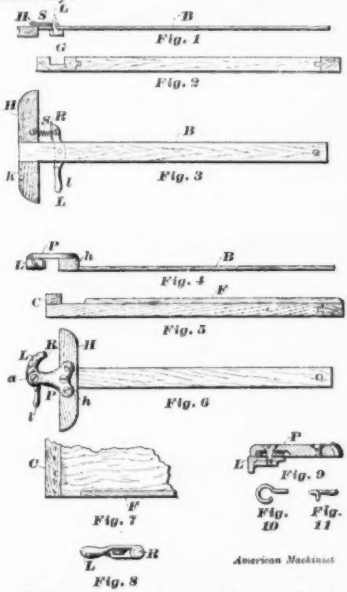
It is noteworthy that whereas an American machine manufacturer criticised the mechanical ability of Americans, a vigorous refutation of the criticism is thus made in the columns of a foreign publication.

Tee-Squares.

THE tee-square and drawing board are among the first implements employed in the development of a mechanical conception. No handy substitutes for them have been found. Simple as they are, much study has been devoted to their construction and improvement. The latest of these studies made public, has been by Mr. Oberlin Smith, who makes in the *American Machinist* some suggestions worth considering. The changes suggested are illustrated in the accompaning cuts. Mr. Smith does not claim these to be entirely original with him; Prof. J. B. Webb, was also a collaborator, and both gave thought and time to the subject.

"The result of these cogitations was a drawing board made as shown in front view in Figure 2, upon which was mounted a special tee-square, as shown in front view, Figure 1, and top view in Figure 3. The general idea originated, as I remem-

ber, with Professor Webb, but was worked out by both of us. The only new feature in the drawing board is a groove *G* near the left hand end about one inch wide and, perhaps, three-eighths inch deep. Beneath the blade of the tee-square *B* was pivoted the lever *L*, the front end of which projected above the drawing board as shown in Figure 1, and the rear end of which was pulled toward the head of the tee-square *H* by the spiral spring *S*, hooked on to two ordinary round-head wood screws, inserted in the head and lever respectively.



"Cemented to the working end of the lever was a small pad of rubber *R*, whose function it was to give more friction against the left side of the groove *G*, when the square was down in place and the lever freely sliding therein. A flat spring, attached to the side of said lever and abutting against a pin projecting downward from the square blade, would, of course, have been as good and somewhat neater. The cheapest way of all would be to hook an ordinary rubber band over the screws, in place of the spiral spring *S*, but in those days these useful little bands were more of a curiosity than now.

"The action of this square is self-evident, inasmuch as the head is firmly clamped against the left edge of the drawing board by the action of the spring and lever, instead of being held there by hand, thus leaving the two hands of the draftsman free to use his triangles, pencils, pens, etc., against the rear edge of the blade. The movement of the square forward and rearward upon the board is obviously as quickly performed as with the ordinary tee-square, as it is just as easy to grasp the slightly indented head with the fingers of the left hand at *h*, with the thumb upon the lever at *l*, at the same time giving a slight pressure to overcome the spring and release the square, as it is to grasp the head of the square itself. In cases where the drawing board lies down flat upon a table the square is indeed easier to grasp than usual, as the fingers do not have to be thrust beneath it. This is a device that can be cheaply applied to any tee-square already in use, providing the drawing board upon which the same is to be mounted will permit, without too much weakening, the planing out of the groove *G*. If desired, this groove can be made under cut on the left side, in dovetail fashion, so as to give a holding down effect upon the square, but in practice we do not find this necessary.

"In Figure 5, in front view, and in Figure 7, in partial top view, is shown a somewhat different type of drawing board, which I have adopted in recent years for my entire equipment. It requires no groove, and the left end is strengthened simply by screwing fast to it the cleat *C*. Incidentally, but having no connection with the use of the tee-square, it may be mentioned that these boards are made with a flange *F* projecting upward from the front edge about one-half inch high. This is often very convenient for preventing the tools from sliding off when the board is inclined, and more especially for resting the true front edge of the paper against in various cases of sketching and designing where it is not necessary to fasten it down, with thumb tacks or otherwise. In fact, nearly all our work is done with the paper thus loose, though possibly

one reason why we do not feel the need of any fastening is that we use cross ruled paper not only for sketching but for all scale drawings.

"The tee-square used upon this board, in cases where not more than three feet of length is required, is shown in front view in Figure 4, top view in Figure 6, etc. It is made like an ordinary tee-square, but with its head reversed, so that it projects upward from the blade and so that its left side slides against the right side of cleat *C*. To this cleat it is firmly held by the iron lever *L*, provided with a rubber pad *R* at its rear end, consisting of an ordinary rubber cork inserted in a drilled or cored hole. This lever, of course, presses against the left side of *C*, thereby clamping the square in any desired position. It is released by pinching the front end at *l* with one or more of the fingers of the left-hand, the thumb resting in a slight indentation *h* at the right side of the head *H*. In Figure 8 is shown a right view of the lever and rubber pad. In Figure 9 is shown a front vertical section of lever *L* and a plate *P*. This latter is fastened to the top of the square with ordinary wood screws, and to it is pivoted the lever by a machine screw. The actuating spring is a simple piece of bent wire shown in section in Figure 9, in top view in Figure 10, and in right view in Figure 11. The straight end of this spring lies loosely in a groove cast in *P*, while the bent down end enters a rough hole cast in *L*."

Mr. Smith declares that, "after several years' experience he would not return to the old drawing board and tee-square, but the improved forms are not advised for use with squares having blades exceeding a length of three feet. For lengths exceeding this the well-known 'Bergner method' is preferable." But the use of elastic steel wire working around pulleys of comparatively large diameter has been found superior in accuracy to the twine and small pulleys employed by Bergner. Mr. Smith claims to have independently invented the device patented by Bergner, though he does not dispute Bergner's priority. This is not an infrequent occurrence in the history of modern invention.

Governing Electric Light Engines.

AN excellent article to read in connection with that upon the Ideal Steam Governor, written by Mr. H. J. Conant, and printed in the October number of this Magazine, is one printed in *The Engineer* (London) in its issue of September 28th. The well known defects of centrifugal governors are treated, and it is editorially stated that the office of the publication named is besieged "at various times and from various quarters with letters complaining of the difficulty which the writers find in obtaining governors which will satisfy the demands of the electrician."

All the centrifugal governors in the market apparently have been tried; not any gives complete satisfaction. It is queried whether the governor needed cannot possibly be made, or whether it is beyond the powers of inventors to produce such a governor. The assumption is made that a negative reply to either of these queries is not necessary to be given, and the reason assigned why the desired governor is not obtained is simply "because the electric light engineers have not explained fully what they want and—which is perhaps more to the purpose—why they want it."

An attempt is essayed to make good this deficiency. The well-known fact that none of the centrifugal governors can act instantly upon a variation of load is cited and a number of illustrations to emphasize this proposition are given.

The great initial difficulty remains untouched, namely, the power of the governor to deal with lightning speed with large alterations in load. What appears to be needed is a governor which the moment the speed drops or rises—say 1 per cent.—will open the throttle valve full or shut it absolutely, and will then by a series of very rapid alterations or oscillations open and close it through smaller and smaller arcs until the new position suited to the load has been attained. Something quite analogous to this is found in the gas engine, and it is by no means certain that the same prin.iple might not be applied with advantage to the steam engine. Messrs. Brown Brothers make an anti-racing gear for marine engines. Mr. Weir has, we fancy, something of the same kind. The moment the engine tends to race, the inertia of a small moving weight

opens a trigger and the throttle valve closes. We have here the fundamental idea of a governor for electric light engines. The isochronal governor complies well enough with the conditions up to a certain point. The balls will remain in any position independent of the speed; it is only a change in speed that will cause them to move in or out, to or from the central spindle; but the isochronal governor is altogether too delicate a plant for the engine-house of an electric light station, and, besides, it is prone to "hunt" to a most distressing degree.

A position is taken which will probably be criticised. The proposition is made that whether the governor acts on the throttle valve or on the expansion gear is a matter of no consequence as far as governing is concerned. In proof of this assertion the statement is made that where an expansion gear governor has been taken off and replaced by the throttle valve governor "excellent results were obtained with no appreciable difference in steam consumption." It is added that "throttle valve governors generally fail because the valve is not properly constructed. There is no sort of relation between the area opened and closed and the position of the governor. The result is of course disappointing."

An arrangement is suggested as being better than those in use, which consists in passing the steam through a circular orifice in a plate in which moves a cone. It is assumed that while a sufficient taper on this cone would require a very long range of motion to make any material alteration in area opened for the steam to pass, if the sides of the cone be curved, "any relations desired may be obtained between the position of the governor and the area for steam admission."

The satisfaction which some electric light engineers find with some of the governors in use is asserted to be based on ignorance. "They do not know what a first rate governor could do for them." In concluding it is claimed that there is "no doubt that any competent inventor who would take the trouble to master the whole question could produce what is desirable." In other words, the governing of steam engines is considered as a very simple problem, or at least, so simple that it ought not to give any serious difficulty. It is doubtful whether this proposition will be accepted by engineers in general, most of whom regard the production of the ideal governor as a matter of considerable difficulty and doubt whether it is possible to so construct a governor that it will regulate the admission of steam simultaneously with variation of load.

The Gas Engine.

IN a lecture delivered by Mr. W. Norris, M. I. M. E., before the Lincoln (England) Schools of Science and Art, he gave an interesting account of the beginnings and progress in this new popular class of motors, which the *American Gas Light Journal* has printed (Oct. 15), under the title "The History and Development of the Gas Engine." The use of explosives in guns was the starting point of invention in this line. Instead of a projectile to be thrown out of a hollow cylinder to a distance, in the gas engine a piston has been substituted. The effort of this piston to escape from the cylinder, as a projectile would do, is arrested by a crank and pitman, and converted into work by the motion of these parts against resistance.

Combustible powder whose rapid burning generates a large volume of heated gas, has been almost wholly employed for artillery. Each separate gun may be regarded as a heat engine, as much as a steam engine or a caloric engine is; and guns were the earliest heat engines, with perhaps the single exception of the Greek æolipile, which, however, was merely a philosophical toy. Attempts were early made to use explosive powder in motors for industrial purposes. It is stated that the first proposition to do this originated with "Abbé Hautville, the son of a baker of Orleans (1678). To him belongs the honor of designing, not only the first engine worthy of the name, but the first machine using heat as a motive force." In this device powder was burned in a vessel communicating by a pipe with a reservoir of water; a large volume of the gases escaped through a valve, and when the residue of the gases cooled after combustion, atmospheric pressure forced water

up through the pipe into the vessel to fill the partial vacuum thus formed. There were many difficulties to be met. Huyghens and Papin endeavored to overcome them, but abandoned their attempts and engaged in experiments with steam. Then for more than a hundred years steam held the innings.

The first to design and construct an actual gas engine is alleged to have been John Barber, who took out a patent for such a machine in 1682. He made his gas from wood, coal oil, or other substances heated in a retort, condensing and cooling the gas in a receiver. The gas was then mixed in the proper proportion with atmospheric air and forced by a pump into a vessel called the exploder. From an aperture in this vessel, the expanding gases issued in a stream and impinging upon the vanes of a wheel caused the latter to rotate. As a supposed aid to this action, a small jet of water was injected into the exploder, and being converted into steam was thought to increase the volume of discharge.

The history proceeds in due sequence to the gas engine invented by Robert Street (1794), in which gas exploded in a cylinder and impelled a piston. This type of gas engine has held supremacy up to the present time. Lebon's gas engine (1799 and 1801) is next in order of time. This though it was in advance of the age, appears to have been the first which indicates an appreciation of the advantage of compressing the mixed air and gas in the motor cylinder prior to the explosion. Sixty years later Lenoir successfully introduced gas engines working on this principle, which is employed in more recent gas engines that have been successful as motors. Next came Brown's invention (1826) in which condensation of the expanded gases was effected by a jet of water. Since this date improvement has been rapid.

Steam Jackets and Separators.

THERE exists in the Canadian Dominion an Association of Steam Engineers, and this body of practical men, recently held a convention at Toronto during which some good papers were read. Among these was one presented by Mr. J. Murphy of Montreal (printed in the *Canadian Engineer* for October) in which points that have come under Mr. Murphy's observation while practically in charge of condensing and compound condensing engines were brought to the attention of the convention.

The fact that there is great difference of opinion with reference to the merits of steam jackets is mentioned but passed with mere allusion to the existence of diverse views of the subject entertained by theoretical as well as practical men.

"In the short space of time that I have been working with jacketed engine and separator, I have seen wonders with regard to good running and efficiency; but it is not my intention to advertise those builders that have already adopted the jacket; it is simply to lay before you what I have found in practice. I will describe as briefly as possible the way that the steam connections to these jacketed engines are designed. The high-pressure steam chest of the engine, and the receiver jacket is supplied from the high-pressure cylinder jacket; the return pipes from the jacket are run to a pump that is situated below the level of the return pipes, and the water that is condensed in the jackets is pumped automatically back to the boilers. The low-pressure cylinder jacket is supplied from the initial pressure of the low-pressure cylinder, and the condensed water from the low-pressure jacket is also pumped back to the boilers automatically with a pump similar to the one for the high-pressure jackets. These pumps can be regulated and worked by hand in case of any disarrangement of the automatic regulating gear. There is also an independent way of draining these return pipes into a cesspool connected with the sewer that is used when making repairs to these pumps, so that you will see there is no further loss than that which is due to radiation. The steam separator is connected with the main steam pipe about ten feet below its level, and at the end of it, so that any water that may get into the main pipe through condensation or otherwise may find its way to the separator,

and is pumped back to the boilers by the high-pressure jacket pump. The separator effects a considerable saving because there are no other drips necessary on the main steam pipe, while such are required on the ordinary steam pipe that is not connected with a separator.

An experience with Brown and Corliss engines in the Royal Electric Company's works during a number of years is given. "That these engines worked well goes without saying. The compound engines were the latest installed at their works, and when I say that these engines worked well I simply say the truth. The entire experience confirms the value of steam jacketing."

INDEX TO LEADING ARTICLES.

The journals quoted are indicated by initials, and their full titles are given in the opening pages of the Review. Other abbreviations are, Ill=Illustrated W=Words.

The Machine Shop.

*25765. Economy in Machine Shop Management.—A Plea for Handy Devices and Handier Workmen. James Brady (E Mag-Dec.) 3500 w.

25777. The Greiner and Erpf Cupola. W. F. Durfee (A M-Oct. 11.) 1300 w.

25779. Figuring Drawings. Oberlin Smith (A M-Oct. 11.) 4000 w.

25910. Welding. S. Uren (R A-Oct. 12.) 2500 w.

*25933. Spratt's Electrical Speed and Direction Indicator. Ill. (Eng. L-Oct. 3.) 1300 w.

25997. Punching Sheet Steel in a Planer.—A Milling Attachment to Planer. Ill. James F. Hobart (A M-Oct. 18.) 1200 w.

26172. A Few Examples in Pattern Making. Ill. John M. Richardson (A M-Oct. 25.) 850 w.

26173. What Is a Chronometer? (A M-Oct. 25.) 1200 w.

26175. Tee-Squares. Ill. Oberlin Smith (A M-Oct. 25.) 1200 w.

26357. The Machinist in the Foundry. Editorial (A M-Nov. 1.) 700 w.

26398. A Large Steel Derrick. Ill. (E N-Nov. 1.) 900 w.

26463. The Slide Rule in the Shop. William Cox (M A-Nov.) 1300 w.

*26536. Drilling Machines for Cylindrical Boiler Shells. Samuel Dixon (I C T-Oct. 26.) 4000 w.

26573. Making Formed Milling Cutters. Ill. Warren E. Willis (A M-Nov. 8.) 1100 w.

26575. Measurement of Areas Bounded by Curved Lines. F. R. Honey (A M-Nov. 8.) 600 w.

26654.—$1.50. Friction Rollers.—Discussion on C. L. Crandall's Paper. J. B. Johnson and A. Marston (T C E-Sept.) 2400 w.

Steam Engineering.

*25820. The Strong Internally Fired Boilers (I & I-Sept. 28.) 1500 w.

25851. Limits of Accuracy of Steam Engine Indicators (R G-Oct. 12.) 800 w.

*25878. Piston Valves for Steam Engines. W. H. Booth (E R L-Oct. 5.) 1400 w.

25887. Steam Jackets and Separators. J. Murphy (C Eng-Oct.) 1700 w.

*25899. The Arrangement and Drainage of Steam Pipes. Editorial (P Eng-Oct. 5.) 1200 w.

25938. Designing Engine Cylinders.—The Effect of Large Clearance Surface on Economy. Ill. (B J C-Oct. 13.) 2500 w.

25939. Feed Pipes Clogged (B J C-Oct. 13.) 1200 w.

25946. First Stationary Steam Engines in America. F. R. Hutton (M G-Oct. 13.) 900 w.

26021. Economy in the Boiler Room. John C. McHynn (S V-Oct. 15.) 1100 w.

26022. Special Automatic Stop Valves in France. Ill. Thomas Powell (S V-Oct. 15.) 1400 w.

26045. Some Interesting Diagrams. Ill. (B J C-Oct. 20.) 700 w.

26046. Boiler Feed Waters (B J C-Oct. 20.) 900 w.

*26159. A Perfected Steam Fire Engine. Ill. (M-Oct. 15.) 2000 w.

*26160. The Management of Steam Engines.—The Engineer's Duties and How He Should Perform Them (M-Oct. 15.) 1300 w.

26174. The Great Boiler Explosion.—"Penny Wise, Pound Foolish." W. Barnet Le Van (A M-Oct. 25.) 800 w.

26301. Some Engine Experiments.—Hot vs. Cold Cylinder Walls (B J C-Oct. 27.) 1400 w.

26302. Corliss Engine Valves.—Short Directions for Setting Them (B J C-Oct. 27.) 1000 w.

26304. The Formation of Scale in Boilers, and in Feed, Circulating and Blow-off Pipes. Ill. (M G-Oct. 27.) 1800 w.

26392. Measuring Power. W. H. Wakeman (S M-Nov. 1.) 700 w.

26393. Testing Indicators (S M-Nov. 1.) 2200 w.

26416. Steam Pipe Covering. Walter Meyer Dickinson (H & V-Sept.) 900 w.

26461. Forced or Natural (?) Draft. Peter H. Bullock (M A-Nov.) 1400 w.

26474. Fly-Wheel Accidents.—A Discussion as to the Probable Causes (B J C-Nov. 3.) 1600 w.

26475. About Blow-Offs.—Common Practice That Is Not Safe (B J C-Nov. 3.) 1300 w.

We supply copies of these articles. See introductory.

26476. Condensation of Steam in Cylinders (B J C-Nov. 3.) 1000 w.

26481. Boiler Explosion at Shamokin, Pa. Ill. (Pr-Nov.) 1600 w.

26482. The Chilling Action of Feed Water. Ill. (Pr-Nov.) 2200 w.

26613. Rivals of the Steam Engine. George Mackie (C E N-Nov.) 1800 w.

Miscellany.

*25683. Governing Electric Light Engines. Editorial (Eng L-Sept. 28.) 1400 w.

*25823. Description of Bell's Asbestos Manufactory, Southwark Street. Ill. (I & I-Sept. 28.) 2800 w.

*25864. The Windmill in Theory and Practice. V. E. Johnson (Inv-Oct. 6.) 1600 w.

*25893. American Machine Tools. T. F. Hagerty (I C B-Oct. 5.) 4000 w.

25911. The History and Development of the Gas Engine. W. Norris (A G L J-Oct. 15.) 2000 w.

*25918. Canal Boat Propulsion. Ill. Henry Barcroft (E-Oct. 5.) 2100 w.

25942. Machine Operators' Specialties, etc. C. R. Tompkins (A S-Oct. 13.) 1200 w.

25982. A Drafting Room System (Ir Age-Oct. 18.) 1400 w.

25996. Compressed Air for Cleaning Carpets. Frank Richards (A M-Oct. 18.) 1500 w.

*26116. The Semet-Solvey Coke Oven at the Antwerp Exhibition (C G-Oct. 12.) 2400 w.

†26155. The Swiss Watch Schools. Ill. Theodore B. Wilson (P S M-Nov.) 1800 w.

†26333. Test of Otto Gas Engines. J. V. MacDonald, B. G. Braine, C. H. Merritt, Jr. (S In-July.) 1800 w.

26349. The Mechanic Arts and Modern Educations. R. H. Thurston (Sc A S-Nov. 3.) 5000 w.

26462. Hints for Machinists and Engineers. Ill. James F. Hobart (M A-Nov.) 1200 w.

26464. Boiler-Room Accidents. W. H. Wakeman (M A-Nov.) 2200 w.

26483. Stresses Produced in Fly-Wheel Arms by Change of Load or Sudden Stoppage. C. V. Kerr (Pr-Nov.) 1000 w.

*26492. The Friedburg Apparatus for Burning Coal Dust. Ill. (I & I-Oct. 26.) 1300 w.

*26514. Rolled Weldless Chains, Klatte's Process. Ill. (Eng L-Oct. 26.) 1400 w.

†26555. The American Gas Furnace Company's Fuel Gas System and Apparatus. Ill. (J F I-Nov.) 2800 w.

Serials.

13033. Practical Hints to Boilermakers and Templaters. Ill. (M W-Began May 12—14 parts to date—30 cts. each).

13534. The Gas Engine. Ill. (M W-Began June 2, 1893—12 parts to date—30 cts. each).

17900. Machine Shop Milling Practice. Ill. Horace L. Arnold (A M-Began Dec. 7, 1893—14 parts to date—15 cts. each).

18044. Motive Power and Gearing. Ill. E. Tremlett Carter (El-Began Dec. 1, 1893—23 parts to date—30 cts. each).

19638. Blowing Engines and Machinery. Ill. Albrecht von Ihering (E M-Began Feb—9 parts to date—30 cts. each).

20182. The Elements of Boiler-Making. Ill. C. E. Fourness (L E-Began March—9 parts to date—30 cts. each).

21141. High Speed Steam Engines. John Redinger (E M—Began April—8 parts to date—30 cts. each).

23826. Comparison of Different Formulæ for Dimensions of Parts of Steam Engines. William Kent (A M-Began July 26—6 parts to date—15 cts. each).

24930. Some Notes for Enginemen and Firemen. W. H. Booth (E L-Began Aug. 31—6 parts to date—30 cts. each).

25193. Electrical Machinist Practice. Ill. James F. Hobart (E E N Y-Began Sept. 19—8 parts to date—15 cts. each).

25528. The Designing and Construction of Modern Steam Engines. Theodore F. Scheffler, Jr. (M A-Began Oct.—2 parts to date—15 cts. each).

25531. On Resistance of Trains of Mechanism. Ill. Leicester Allen (M A-Began Oct.—2 parts to date—15 cts. each).

25538. Testing of Engines and Boilers. Ill. Charles Day (P Eng-Began Sept. 21—4 parts to date—30 cts. each).

25563. Spacing Holes. Ill. Easy Way (A M-Began Oct. 4—2 parts to date—15 cts. each).

25735. Notes on the Steam Turbine. Kenelm Edgecumbe (E R L-Began Sept. 28—Ended Oct. 19—4 parts—30 cts. each).

25922. Some Points in the Testing of Steam Engines (I & I-Began Oct. 5—4 parts to date—15 cts. each).

25923. Waste of Energy in Machinery (I & I-Began Oct. 5—2 parts to date—30 cts. each).

26044. The Magnitude and Importance of the Industries Involved in Wire (Inv-Began Oct. 13—3 parts to date—30 cts. each).

26104. Fire Protection in Mills and Factories. Ill. (F W-Began Oct. 20—Ended Oct. 27—2 parts—15 cts. each).

26154. Manual Training. C. Hanford Henderson (P S M-Began Nov.—1 part to date—45 cts).

26181. Refrigerating Machines. Ill. A. R. Gale (M W-Began Oct. 19—2 parts to date—30 cts. each).

26250. The Modern Gas Engine. E. Rollason (P Eng-Began Oct. 19—Ended Oct. 26—2 parts—30 cts. each).

26488. American Steam Raising Plant. Ill. (I & I-Began Oct. 26—1 part to date—30 cts).

26590. Changing a Steam Plant to Improve Economy. Thomas Hawley (B J C-Began Nov. 10—1 part to date—15 cts).

26598. Fly-Wheel Accidents. J. J. Flather (E W-Began Nov. 10—1 part to date—15 cts).

We supply copies of these articles. See introductory.

MINING & METALLURGY

Physical Properties of Fuels.

In a contribution to the *American Manufacturer* Mr. John Fulton presents a clear and rational explanation of the behavior of metallurgical fuels in the blast-furnace, showing why certain results apparently discordant if viewed only from the standpoint of chemical composition are the natural outcome of the different physical properties of the fuels. In American blast-furnace practice, as elsewhere, charcoal was the first and sole fuel. Later it was replaced in part by anthracite; and later still coke has taken the ascendancy, while mixtures of coke and coal remain in use. Mr. Fulton reviews these changes, giving statistics of the relative proportion of each fuel used at different periods, and setting forth the reasons for the changes.

In the examination of the physical structure of these three principal fuels, he observes, it will readily appear that charcoal inherits the structure of the wood from which it has been made, and that its structure consists of a series of longitudinal tubes, uniting with each other and affording a passage for the furnace gases. The walls of these tubes are readily oxidized; charcoal is therefore a moderately energetic fuel, as well as one of remarkable purity. But with an ever widening sweep of the charcoal supply from the furnace, and with increasing cost, it was forced to take a secondary place among metallurgical fuels, and with the advent of anthracite coal in blast-furnace use a new period in the manufacture of iron was opened.

Anthracite he considers to be a natural coke, made under immense pressure and heat. It is the densest of all fuels, as it practically inherits neither cells nor pores, but is a mass of fused and compacted coal. Because of its physical structure it is the least energetic of the fuels under consideration; but its combustion in the furnace is somewhat relieved by decrepitation, thus increasing the surface exposed to oxidation. Its hardness enables it to withstand great furnace burdens, and also enables it to resist dissolution by hot carbon dioxide.

Coke is made in ovens by destructive distillation, somewhat similar to the methods of preparing charcoal; but Mr. Fulton points out the important difference that coke results from the fusing of the coal and does not inherit any traces of the structure of the coal, while on the other hand it acquires a series of irregular cells connected with each other, thus affording the largest surface to the action of the furnace gases, and hence is the most energetic fuel of the three. Its hardness enables it to bear the burden of the highest furnaces and resist dissolution by hot gases. Thus it embraces in harmonious combination the best properties of charcoal and anthracite.

Mr. Fulton shows by figures that the assumption that a pound of carbon in any fuel should produce equal calorific results does not hold good in iron smelting. It is quite evident, he says, that the cause for the difference in the calorific work of these fuels is not to be found in the chemical composition, for the best product per pound of fuel and unit of carbon is given by the coke, which is the least pure of the three (that is, including ash), and that it follows, then, that the superior value of the coke is due to its physical structure. In the best qualities the cellular spaces in the whole volume of the coke are practically 50 per cent. and the aggregate surface of this cellular development with the slender columnar structure of the coke, secures the utmost calorific energy in the furnace and the greatest economy of fuel. Charcoal, with its tubes and enlarged outer surface, surpasses anthracite because of its physical properties, while coke largely surpasses both. Comparisons are made by Mr.

Fulton between the working of three typical furnaces, each running on one of the three fuels alone, but otherwise under similar conditions. As to amount of product, taking the total output of the three at 100, they stand: charcoal, 30 per cent.; anthracite, 17 per cent.; coke, 63 per cent. And comparing the speed of production, taking the charcoal furnace at 100, the showing is: anthracite, 80 per cent.; coke, 311 per cent.

Slate: Its Formation, Extraction and Uses.

IN the *Canadian Mining Review*, Mr. H. J. Williams discusses the utility and value of slate, its occurrence and distribution, especially in the province of Quebec, and the methods of extraction and use, and calls attention to the growing importance of the slate industry. The author takes the risk of saying that no clay slate of any value is found in the Laurentian range or anywhere in Ontario, and proceeds to give a list of occurrences in Quebec, mentioning the places where quarries have been operated. He considers that from the number and variety of the slate deposits of the latter province it would appear that many remunerative quarries might be opened.

The author gives an account of the composition and geological origin of slate and then proceeds to describe the working of a quarry. He takes occasion to remark that there is no mining in which such intelligence, skill and judgment are required on the part of the employés as in the quarrying and working of slate. The method of quarrying is dependent upon the locality of the opening, the condition of the formation and the position relative to the surrounding rocks. It may be: (1) an open quarry; (2) a chambered quarry worked underground by adits and levels; or (3) an underground working opened by shafts. The author confines himself to a description of the first only, as with one exception all the quarries worked on this continent are of that class. In the Canadian slate beds the weathered covering is from 30 to 40 feet in depth, all of which has to be removed before sound slate can be reached. An opening is made along the face and another across the "vein." This portion is quarried back, another bench started in the same way and so on until the opening is laid out in a succession of steps. The next operation is the quarrying of blocks, and it is here that the most intelligence is necessary, it being imperative that the block shall be got out without shattering, and the skill of the quarryman is tested by his ability to take advantage of the slips, joints and floors to make each hole do its work properly. In some cases wedges are used, but usually blasting is resorted to. Ordinary black blasting powder is used, as the force wanted is a dull, heaving one which will displace the rock without breaking it. The higher explosives are of course inadmissible. The author next describes the cutting up of the large block by hand into convenient sizes for hoisting and trimming. In working these pieces into "slate" skilled labor again is requisite, and "slate makers," so-called, who usually work in pairs, study their block that they may make the most slate therefrom. The most important product is roofing slates, and the manner of splitting and trimming these and school slates is given. Another large and growing branch of the industry is in the milling of slate. There is no rock which so nearly resembles wood as this, and hence it is cut by circular, band and jig saws, and is machine-planed. For interior construction and ornamental use it is often "marbleized," and can also be used for tanks and vessels containing water. The other uses of milled slate are very numerous and varied. Among these are billiard table beds, blackboards, monuments, and switchboards and instrument stands for electrical purposes, etc. Mr. Williams mentions also one other use of rough slate which promises to be a very important branch of the industry—the grinding of the rock into dust from which is made a brick whose compactness and wearing qualities are unexcelled; and in the same way tiles of various colors, plain or glazed. are produced.

At present the slate industry of Quebec is confined to two large, well equipped quarries, at New Rockland and Danville.

Broken Stamp Stems and Crystallization by Vibration.

THE discussion started in the American Institute of Mining Engineers as to whether or not stamp stems break because of vibration and incessant shocks is not yet closed. *Engineering News* has adverted to the matter on several occasions, and in a recent issue returns to it, the occasion being a report from El Callao mill, Venezuela, in which the crystallization theory is reaffirmed. At this mill a record has been kept of the breakages, which, with 60 stamps running, for five years showed an average life of about 46 weeks, which is rather low. The stems are wrought iron $3\frac{7}{8}$ inches diameter; total weight of stamps (when new), 848 pounds; speed, 95; drop, 8 inches. The stems alone weigh 392 pounds. The writer of the report says: "I believe as a rule the broken stems are due to the metal crystallizing. Slight differences in vibration and strain and composition of metal vary the length of time required to crystallize sufficiently to cause a fracture. The average life of the stems shows that generally the fracture is not due to flaws or heterogeneous metal, although this is sometimes the cause." Commenting upon this, *Engineering News* remarks that if there was some approach to uniformity in the life of these stems, "the evidence is good that some deteriorating influence was at work upon the stem from the time it was put in service. If the breakage were due to a chance hit giving a side strain, then such a chance hit would be as likely to occur at one time as another, and after the small percentage of stems with flaws was eliminated the 'death rate' should remain fairly constant, and there should be a fairly large number of stamps [stems] which would run for two years without breaking, and an occasional one should attain a much longer period of service."

As our contempory says, there are probably few better places to test the effect of vibration and shock on metal than a stamp mill, with its steady day and night work and its continual concussion.

Engineering News has advanced a novel hypothesis to account for the battery stem phenomena, namely, that it might be possible that "the compression at the lower end of the stem [where it usually breaks] might exceed the elastic limit of the metal. What the effect of such repeated compression beyond the elastic limit would be can only be conjectured; but we know that repeated stretching of metal beyond the elastic limit gradually makes it brittle. It is not unreasonable to suppose therefore that repeated compression of metal may cause a 'fatigue' that will gradually diminish its ability either to resist a steady strain or to absorb without rupture the energy of a blow." This is based upon the weght of tappet and stem above the point of fracture and also upon the material which the stamp shoe struck. This, with self-feeders or careful hand-feeding, is always a cushion of rock, and not the chilled cast-iron of the die, which latter appears to be a necessary assumption in our contemporary's hypothesis.

Engineering News recommends careful experimentation to determine this vexed crystallization question, and suggests it as a good field for thesis work by students of the western mining schools.

Steel vs. Wrought Iron.

THE *Practical Engineer*, taking as its test recent returns collected by the British Iron Trade Association, presents a vivid picture of the extent to which steel has replaced wrought iron as a constructive material, and further how open-hearth steel has gained upon and at length passed its rival, Bessemer steel. It is less than forty years since the Bessemer process was first made public, and it was not until ten years later that Siemens introduced the open-hearth method for the manufacture of steel; yet during this short period, which is practically much shorter because of the very slow growth of both processes at the beginning, there has been a complete revolution. It is a familiar history, the wonderful progress made by the Bessemer process, but it is not so generally known perhaps that another revolution has been quietly going on, the open-hearth steel having at length outrivaled the Bessemer. This change is

well shown by the *Practical Engineer* in its comparison of the British statistics for 1890 and 1894. In the first-named year the total output of steel in Great Britain was 3,579,000 tons, of which 2,015,000 tons were Bessemer and 1,564,000 tons open-hearth. In 1894 the positions have changed, the output of open-hearth steel for the first six months of the present year being 1,026,469 tons, while that of Bessemer steel was only 810,392 tons. Thus open-hearth steel has not only largely replaced wrought iron, as was naturally to be expected, but it would also appear that for many purposes it has replaced Bessemer steel as well, though the latter, like wrought iron, will, our contemporary thinks, retain its special sphere of application, owing to its cheaper and more rapid manufacture. On the other hand open-hearth steel is used almost exclusively for purposes where ductility and capacity for subsequent working in the fire are of special importance, in spite of greater cost. Its special applications are for boiler and ship plates, etc., where reliability is the great desideratum.

Taking these two steels together and comparing them with wrought iron, it is shown that while in 1882 the total output of wrought iron in Great Britain was upwards of 2,800,000 tons, for the present year, estimated on the basis of the first six months, it will not exceed 1,000,000 tons. On the other hand the combined output of Bessemer and open-hearth steel is expected to be over 3,600,000 tons for 1894, against a little over 2,000,000 tons in 1882. These changes have brought about correspondingly great economic changes in the districts affected.

Utilization of Blast-Furnace Slags.

THIS old but ever timely subject is admirably discussed in *L'Industrie*, and a translation of the article appears in the *American Manufacturer*. The series of uses, possible and probable, already practically demonstrated or merely suggested, are reviewed concisely. The first and most natural idea, says *L'Industrie*, and perhaps one of the best as well, was to use blast-furnace slags as fertilizers, as is done with the phosphatic slags of steel making. The latter have superior fertilizing qualities, but the blast-furnace slags contain almost no combined iron and can be sold much cheaper. Their action would of course be different. Basic slags, that is, those containing less than 3.2 atoms of oxygen to 1 of silicon, are the slags to be considered. They furnish soluble silica, which is necessary to healthy plant growth, and is deficient in most soils unless the latter contain much alkali. When finely pulverized basic slag is scattered over the ground it decomposes rapidly, giving gelatinous silica and the hydrates and carbonates of the bases, and by reaction with the meteoric ammonia and nitric acid produces nitrogenous products. *L'Industrie* believes that further attention should be given in this direction.

The manufucture of "mineral wool" or "glass wool" is mentioned. This industry began in 1873. Very fair material was made at low cost with the slag run directly from the furnace, but had the disadvantage of containing sulphur, rendering it undesirable as an insulator under some conditions. A better product could be obtained by treating the slag with suitable flux in a cupola. The presence of sulphur is also a drawback which has thwarted almost every attempt to use slags in cement, mortar, artificial stone, etc. When ground sulphurous slag is mixed with slaked lime and water it decomposes. But, provided the slag is not defective in this way, it will give hydraulic properties to mortars. From this it appears that blast-furnace slag would have had quite a commercial importance if it could be freed from sulphur. *L'Industrie* believes that it could be desulphurized in the liquid state as it flows from the furnace, and in an economical way; but this requires the coöperation of the iron manufacturers, who seem to have been indifferent to the matter.

A refined slag would have valuable properties, and it is suggested by our contemporary that it would be especially useful as a component in glaze for porcelain, etc. It is also suggested that there is the possibility of using certain slags in the manufacture of cheap glass, a matter which

however will require much experimentation on a commercial scale.

The Genesis of Gold Placers.

THERE has been such a mass of literature, both in the form of official reports and of a more ephemeral sort regarding the origin and modes of occurrence of the auriferous gravels of California that the straw would seem to have been pretty well threshed out by this time; yet Mr. R. L. Dunn, in a two-part serial in the *Mining and Scientific Press*, has succeeded in presenting the subject in a somewhat new light, adding to the former literature (of which Whitney's "Auriferous Gravels" is the most prominent example) the results of observations made within the last few years and bringing the whole together in connected form.

Perhaps the most important point brought out in Mr. Dunn's paper is that the two principal types of placers, those of the existing streams and those of the Tertiary streams (the "deep" gravels), generally supposed to include all of the placer deposits of California, are in fact not the only ones. During the last two years, according to Mr. Dunn, the former notion has been disproved and there must be added two additional distinctive classes of placers, considered both with reference to mode of occurrence and to geological origin. One newly recognized form proves to be the gravel-filled bed of a Cretaceous or possibly Jurassic river (that is, of older origin than is attributed to other deep gravels), and is a conglomerated deposit. The other new type consists of marine conglomerates of Jurassic age.

The practical application of geological investigation of the placers is thus stated by the author: "A clear understanding of the phenomena of placer gold occurrence and distribution will likely prove of considerable assistance in determining the probable gold content of placers. Though it is not at all probable that any set of rules would prove conclusive in application to determining the gold content of every placer deposit, yet it is possible to so apply an exact knowledge of the formation of particular deposits as to have an added certainty to the correctness of conclusions relating to its mining."

Deep Mines on the Witwatersrandt.

THE persistency of the great "banket" lode of the 'Randt in depth has already been fully established by the diamond-drill holes which have been bored, and now deep shafts are being sunk at several points to exploit the lode. The *South African Mining Journal* gives details of the work thus far done, from which it appears that three shafts have reached depths of more than 800 feet. Where the "reef" has been struck it is said to be in every respect identical with that worked near the surface, so that the prosperity of this great gold-mining district is assured for a long time to come. One of the shafts (960 feet deep) was sunk without the aid of a pump and without rock drills in 24 months, the best record being 61 feet, in July. The shaft is not a very large one (5 feet by 9 feet 6 inches, inside timbers). The work was done by native labor and is interesting as showing what can be done by the native miners. They work in eight-hour shifts and are required to clean up the loose rock, which occupies about two hours. The water was all baled by skip. Comparing hand-drilling with rock drills, the *Journal* says that while the latter are more rapid, hand labor is less expensive—a state of things which does not generally prevail in other districts, and is doubtless due to the character of the labor employed on the 'Randt. The article cited gives full particulars as to work in several shafts and as to the surface plants erected.

Experiments With Mining Explosives.

THE *Colliery Guardian* contains a report of some experiments recently made in Wales for the purpose of testing certain explosives as to their safety for use in coal mining and also as to strength. The especial object was to compare the new "flameless" explosive westphallite with other brands, and although these tests were made under the auspices of interested parties, they are of considerable interest.

The tests as to safety were made in a horizontal iron boiler 30 feet long, in which the various explosives were fired in such manner as to represent blown-out shots. The apparatus was arranged to represent the condition of a dry colliery, (1) with coal dust and (2) coal dust in the presence of a measured quantity of inflammable gas. Observations were made through a series of windows along the sides. In the first set of tests dynamite, tonite, roburite, bellite and ammonite produced complete ignition of the dust, with large flame and explosion; while westphallite, andeerpowder and carbonite failed to ignite it. In the second set of tests the object was to ascertain whether the explosives which had not ignited the coal dust alone would cause an explosion in a mine where both dust and fire damp were present. The three explosives which passed the first trial successfully also succeeded in the more severe test, while roburite (which is considered a fairly safe explosive) caused an explosion with flame apparently of gas only. The tests for strength consisted in firing a 35-pound projectile from a mortar with 10 grams of charge, and measuring the distance to which the projectile was sent. The table shows the following order of apparent strength: dynamite, roburite, westphallite, bellite, ammonite, tonite, carbonite, andeerpowder.

An Aerial Ropeway at an Australian Colliery.

AN account is given, in the *Australian Mining Standard*, of a plain endless ropeway lately installed at the Jumbunna colliery in the Gippsland district of Victoria for the haulage of coal from the mine tunnels to the railroad. The distance is one mile and the difference of elevation only 300 feet at terminals, with an up-grade to the railroad, but surveys showed that the construction of a branch railroad would have been so expensive as to be economically out of the question, on account of sharp curves and heavy grades over intervening country. The capacity of the line is 30 tons per hour. The case is interesting because of the selection of the plain single-rope system in preference to either of the more recently developed cableways.

INDEX TO LEADING ARTICLES.

The journals quoted are indicated by initials, and their full titles are given in the opening pages of the Review. Other abbreviations are, Ill=Illustrated; W=Words.

Metallurgy.

*25760. Electrical Power in the Iron Industries.—English and American Practice Compared. D. Selby-Bigge (E Mag-Dec.) 3500 w.

*25762. Aluminum the Super-Abundant Metal.—Present and Prospective Uses. Henry Wurtz (E Mag-Dec.) 3500 w.

25776. Modern Blast Furnace Practice. Editorial (Ir Age-Oct. 11.) 1000 w.

*25821. The Making of Tool Steel in Sweden (I & I Sept. 28.) 1000 w.

25842. Aluminum Bronze. Leonard Waldo (E N-Oct. 11.) 900 w.

25855. New Cupola, with Adjustable Annular Air Inlet. Ill. J. B. Nau, with Discussion (I T R-Oct. 11.) 2000 w.

*25869. Cyanide Processes on the Randt. Editorial (Min W-Oct. 6.) 1200 w.

25886. Methods of Cooling Steel. E. T. Clarage (Eng-Oct. 13) 1000 w.

*26057. Continental Competition in Iron and Steel (I & S-Oct. 13.) 2000 w.

*26058. Dressing of Spathic Iron Ore. G. Gromier (I & S-Oct. 13.) 1000 w.

26112. Suggestions for Building a Modern Blast Furnace. Ill. Guy R. Johnson (E M J-Oct. 20.) 1400 w.

*26146. The Cost of Treating Gold Tailings. (M J-Oct. 13.) 1000 w.

26167. Steel Boiler Tubes and Their Tests. Ill. (Ir Age-Oct. 25.) 1000 w.

26169. Reform Needed in the Bar Iron Trade. Editorial (Ir Age-Oct. 25.) 1000 w.

26170. The Armor Plate Frauds. Ill. Gus C. Henning (A M-Oct. 25.) 1500 w.

26203. Manufacture of Metals of the Alkalies and Alkaline Earths by Electrolysis. Ill. W. Borchers (Sc A S-Oct. 27.) 700 w.

*26226. The Future of Steel Manufacture (C G-Oct. 19.) 1200 w.

26241. Utilization of Blast Furnace Slags. (A M & I W-Oct. 26.) 1200 w.

*26246. American and English Iron making Conditions. Editorial (I C T-Oct. 19.) 1100 w.

*26252. The Wasting and Protection of Iron in Sea Water. (Extract.) C. Colson (P Eng-Oct. 19.) 1100 w.

*26257. Gold Mills. Editorial (M J-Oct. 20.) 1600 w.

26265. Manufacture of Steel Castings. James Larkin (F D-Sept.) 3000 w.

We supply copies of these articles. See introductory

26266. The Fortimolite Process (F D-Sept.) 3000 w.

26291. Early Quartz Milling in Grass Valley, California. G. F. Deetkin (E M J-Oct. 27.) 800 w.

26294. Notes on the Treatment of Copper Scrap. Maurice Barnett (E M J-Oct. 27.) 1500 w.

26296. British Drift from Iron to Steel. Extract from London Times (I T R-Oct. 25.) 700 w.

*26339. The New Recovery Process.—More Important Than MacArthur-Forrest.—Electrical Precipitation from Cyanide Solution, with Editorial (A M S-Sept. 29.) 3500 w.

26358. Notes on Relative Tests for Cast-Iron, and Methods of Testing. Thomas D. West (A M-Nov. 1.) 4000 w.

26366. Comparison of Strength in Specialty Mixtures of Cast-Iron. Thomas D. West (Ir Age-Nov. 1.) 4000 w.

26396. Broken Stamp Stems and Crystallization by Vibration (E N-Nov. 1.) 1600 w.

26415. Chromic Iron. Its Properties, Mode of Occurrence and Uses. I. J. F. Donald. II. J. Obalski (C M R-Oct.) 4800 w.

*26465. Steel vs. Wrought Iron. Editorial (P Eng-Oct. 26.) 1000 w.

26493. Physical Properties of Metallurgical Fuels. John Fulton (A M & I W-Nov. 2.) 1500 w.

26494. The Volatility of Metals and Refractory Substances (A M & I W-Nov. 2.) 1400 w.

26521. Losses of Gold and Silver in the Fire Assay. Howard V. Furman (E M J-Nov. 3.) 700 w.

26522. Electrical Precipitation from Cyanide Solution. A. von Gernet (E M J-Nov. 3.) 2000 w.

26533. Some Remarks on the Cyanide Process. Edward A. Schneider (M I T-Nov. 1.) 800 w.

*26541. Gold Mills. Editorial (M J-Oct. 27.) 1700 w.

26583. The Capillary-Electrolytic Sluice in the Extraction of Gold. Joseph H. Jory (E M J-Nov. 10.) 1300 w.

Mining.

*25341. The Shaw Gas Tester. For Detecting the Presence and Percentage of Fire-Damp and Choke-Damp in Coal Mines, etc. Joseph R. Wilson (M J-Sept. 15.) 2700 w.

†25362. Stone Burning. F. J. E. Spring (I E-Aug. 25.) 800 w.

*25757. The Outlook in the Silver Mining Industry, in the Light of Recent Developments. Albert Williams, Jr. (E Mag-Dec.) 3500 w.

*25815. The Lithographic Stone Quarries of Bavaria, Germany. Ill. A. R. Crook (S-Oct.) 2000 w.

*25817. The Quarrying Industry in Indiana. Maurice Thompson (S-Oct.) 2000 w.

25870. Deep Level Mines of the Witwatersrand. (Abstract.) (E M J-Oct. 13.) 1200 w.

25871. The Georgetown Mining District, Montana. Ill. R. G. Brown (E M J-Oct. 13.) 9000 w.

*25921. Electric Traction by Accumulators in Mines. Ill. Joseph Libert (I & I-Oct. 5.) 6400 w.

*25925. Shaft-Sinking with the Aid of Divers. (Extract.) Ill. G. Nordenstrom (C G-Oct. 5.) 4800 w.

*25926. The Material Removed in Winning Iron Ore. Walter J. May (C G-Oct. 5.) 800 w.

*25928. A Year's Work in Colliery Drainage (C G-Oct. 5.) 700 w.

*25949. A Typical Concentrating Mill. Ill. E. H. Davies (M J-Oct. 6.) 1000 w.

*25950. The Copper Prospects of New South Wales. Editorial (M J-Oct. 6.) 700 w.

26067. Centrifugal Mine Ventilators. Ill. R. O. Jones (A M & I W-Oct. 19.) 3000 w.

26110. The Phosphates of Tennessee. Ill. Thomas C. Meadows and Lytle Brown (E M J-Oct. 20.) 1300 w.

26111. The Development and Future Prospects of Mining in Arizona. John F. Blandy (E M J-Oct. 20.) 1800 w.

26113. Ballarat. T. A. Rickard (E M J-Oct. 20.) 1000 w.

26114. Copper Deposits on the Kirghiz Steppes, Siberia. Ill. (E M J-Oct. 20.) 1100 w.

*26117. Structure of the Hainaut Coal Basin (Extract.) M. A. Briart (C G-Oct. 12.) 6000 w.

*26120. The Coalfields of Labuan, Borneo (Abstract.) Robert Fisher (C G-Oct. 12.) 1800 w.

†26156. Redonda and Its Phosphates. Fred W. Morse (P S M-Nov.) 4400 w.

26177. The Los Angeles Oil Developments (M S P-Oct. 20.) 1200 w.

*26227. Automatic Moving of Tubs at the Anzin Colliery. Ill. (C G-Oct. 19.) 2800 w.

26239. The Mine Fire at Packer No. 5 Colliery. Ill. Baird Halberstadt (A M & I W-Oct 26.) 3600 w.

*26258. New Gold Fields in South Africa. Editorial (M J-Oct. 20.) 900 w.

26292. The Sabinas Coalfield. Ill. E. G. Tuttle (E M J-Oct. 27.) 2500 w.

26297. The Use of Steel Beams in Mines. Ill. (I T R-Oct. 25.) 500 w.

*26318. Indian Mineral Production (B T J-Oct.) 1000 w.

*26335. The Aerial Rope or Cableway System of Transport as Applied to the Development of the Coal Fields of Victoria (A M S-Sept. 22.) 2000 w.

*26337. South Australian Goldfields (A M S-Sept. 22.) 900 w.

*26340. The Gold-Bearing Formation of the Thames (N. Z.) J. Parke (A M S-Sept. 29.) 2000 w.

26384. Gold in the South. Henry V. Maxwell (T-Nov. 1.) 2500 w.

26390. Placer Diggings of the Cape Horn Country (Min R-Oct. 25.) 1500 w.

26412. Mining in British Columbia. Robert C. Adams (C M R-Oct.) 3000 w.

26413. Slate: Its Formation, Extraction and Uses. H. J. Williams (C M R-Oct.) 3500 w.

*26452. Experiments with Explosives for Mining Purposes (C G-Oct. 26.) 8000 w.

26523. Gold Mining in Ecuador. A. F. Saabye (E M J-Nov. 3.) 1300 w.

*26543. The Quarries of Jerusalem. O G. Woods (A L-Oct. 26.) 1700 w.

26565. Origin and Formation of Gold Veins (Min R-Nov. 1.) 1800 w.

*26568. Prevention of Roof Falls. Ill. Joseph Hemingway (C E-Nov.) 4500 w.

26581. Production of Potash Salts in Germany (E M J-Nov. 10.) 1700 w.

26582. The Waste Dump of the Havre Coal Mines, Belgium Ill. Adolph Demeure (E M J-Nov. 10.) 700 w.

26584. The Deep River Coalfield of North Carolina and the Egypt Coal Company's Plant. E. G. Tuttle (E M J-Nov. 10.) 1200 w.

26585. The Australian Mining Laws. T. A. Rickard (E M J-Nov. 10.) 800 w.

26607. The Sydney Coalfield of Cape Breton, Nova Scotia. Hugh Fletcher (Sc A S-Nov. 10.) 2400 w.

*26645. The Goldfields of West Australia.—Interview with C. A. Moreing (Min W-Oct. 20.) 2800 w.

*26646. What Is the Position of the Consolidated Goldfields of South Africa? (Min W-Oct. 27.) 1000 w.

Miscellany.

25775. Reminiscences of John Fritz.—Address to the Mining Engineers (Ir Age-Oct. 11.) 6500 w.

25806. Measurement by Miner's Inch (M S P-Oct. 6.) 1700 w.

*25818. Quincy Granite and Its Manufacture. Ill. (S-Oct.) 3000 w.

†25962. The Eight-Hours' Bill for Miners.—Its Economic Effect. Emerson Bainbridge (C R-Oct.) 6800 w.

25992. Chief Sources of Aluminum. C. W. Hayes (Sc A S-Oct. 20.) 1650 w.

26204. The Bronze Age in Europe. William H. Knight (Sc A S-Oct. 27.) 2800 w.

26264. The Pullman Foundries. Ill. John T. Bramhall (F D-Sept.) 1800 w.

*26451. Electric Haulage in Mines. Joseph Libert (C G-Oct. 26.) 4800 w.

*26454. Notes on the Manufacture of Coal Briquettes, as Carried on in France in 1872. William Pole (C G-Oct. 26.) 1000 w.

26579. Mining and Railroading Within the Arctic Circle. P. T. Lidner (E M J-Nov. 10.) 2000 w.

Serials.

20413. Mining Methods. Ill. (C E-Began March—9 parts to date—30 cts. each).

20414. Geology of Coal. Ill. (C E-Began March—9 parts to date—30 cts. each).

20415. Mining Machinery. Ill. (C E-Began March—9 parts to date—30 cts. each).

20416. Chemistry of Mining. Ill. (C E-Began March—9 parts to date—30 cts. each).

21369. Press Work of Sheet Metals. Ill. Oberlin Smith (Ir Age-Began April 19—Ended Oct. 18—9 parts—15 cts. each).

21814. Plate Moulding. Ill. J. Horne (P Eng-Began April 27—9 parts to date—30 cts. each).

23207. The Origin and the Mode of the Formation of Coal. Adolph Firket (C G-Began June 22—7 parts to date—30 cts. each).

23685. Calculating Weights for Estimates. Ill. J. Horner (A M-Began July 19—4 parts to date—15 cts. each).

24036. Metal Mining. Albert Williams, Jr. (C E-Began Aug.—3 parts to date—30 cts. each).

24075. Manufacture of Tin-Plates (I & I-Began July 27—4 parts to date—30 cts. each).

24362. Methods of Mine Timbering. Ill. (M S P-Began Aug. 11—Ended Oct. 6—5 parts—15 cts. each).

25384. Rustless Coatings for Iron and Steel. M. P. Wood (A M-Began Sept. 27—3 parts to date—15 cts. each).

25572. Mineral Resources of the United States. John Birkinbine (M J-Began Sept. 22—4 parts to date—30 cts. each).

25689. A Typical Gold Mine Region.—Cripple Creek, Col. Ill. Arthur Lakes (C E-Began Oct.—2 parts to date—30 cts. each).

25980. The Casting Temperature of Soft Steel (Ir Age-Began Oct. 18—2 parts to date—15 cts. each).

26017. The Genesis of Gold Placers (M S P-Began Oct. 13—2 parts to date—15 cts. each).

26031. European Phosphates. C. C. Hoyer Millar (M R-Began Oct. 19—4 parts to date—15 cts. each).

26118. Iron Ores. John Randall (C G-Began Oct. 12—3 parts to date—30 cts. each).

26139. Aluminum. A. Humboldt Sexton (P Eng-Began Oct. 12—1 part to date—30 cts).

26145. The Mining Districts of Coolgardie (W. A.) (A M S-Began Sept. 15—2 parts to date—30 cts. each).

26256. Some Notes on Persian Mining and Metallurgy. (Extract.) James Mactear (M J-Began Oct. 20—Ended Oct. 27—2 parts—30 cts. each).

26293. The Zinc Mining Industry of Southwest Missouri and Southeast Kansas. J. R. Holibaugh (E M J-Began Oct. 27—3 parts to date—15 cts. each).

26386. Proper Foundry Construction and the Apparatus to Be Used. Simpson Ballard (T-Began Nov. 1—1 part to date—15 cts).

26496. Construction and Working of Regenerator Settings of Retorts. W. R. Chester (A M & I W-Began Nov. 2—1 part to date—15 cts).

26556. The Phosphates of the World. Francis Wyatt (J F I-Began Nov.—1 part to date—45 cts).

26561. The Cornwall Ore Hills. John Birkinbine (Ir Age-Began Nov. 8—1 part to date—15 cts).

We supply copies of these articles. See introductory.

MUNICIPAL ENGINEERING

Public Ownership of Gas Properties.

MR. WALTON CLARK, in a paper published in the *American Gas Light Journal* (October 29), makes an able argument against municipal ownership of gas works. The argument is in the nature of a reply to arguments contained in two monographs, to wit, "The Relation of the Municipality Ownership to the Gas Supply," by Prof. Edmond J. James, Ph. D., (University of Pennsylvania), and "Municipal Ownership of Gas in the United States," by Prof. Edward W. Bemis, Ph. D. (Chicago University). Professor James advances the proposition that the burden of proof lies on the opponents of public ownership. Mr. Clark regards the true and necessary functions of municipal authority to be the following: "Provision and maintenance of public improvements, *i. e.*, pavements, parks, sewers, public buildings, etc., and exercise of the police power; the latter covering the protection of the health and peace of the community, and the property of the citizens. Its business is to protect property and person, leaving to individuals all the liberty compatible with this protection. Municipalities are purely artificial. Being formed to aid and protect men in the legal exercise of their various talents, they should not assume any function that it is not clearly evident cannot be performed by individuals or associations of individuals without harm to the general interest. The assumption by a municipality of any function that can be performed by individuals is thus an interference with the natural order that demands a complete demonstration of public advantage for its justification; therefore the contrary of Professor James' proposition is true and the burden of proof is on the advocates of public ownership."

Professor James, speaking for himself and other advocates of municipal control, makes the following propositions:

"1. Public ownership is the natural system in all cases of necessary monopolies.

"2. Gas distribution involves occasional disturbance of the surface of the street. The streets are the proper care of the municipality, and, therefore, any business involving their disturbance should be controlled by the municipality.

"3. As a large consumer of gas in street lighting, the city has an interest in gas manufacture that justifies it in establishing municipal works.

"4. Public ownership of industries tends to purity and efficiency in the management of public affairs.

"5. Gas companies are oppressive in their charges, their product is inferior and their function can be better and more cheaply performed by the municipality."

The reply denies that gas is a prime necessity as is water supply. So far is this statement from being true that in the city of Wheeling where gas was sold at 75c. per 1000 cubic feet, there were in 1891 less than 3500 premises consuming gas in a population of 40,000. About one-half of the residences of Wheeling were lighted by other means than gas. The development of the electric light is also gradually reducing the demand for gas, and has already very largely reduced it. "Pure water is the prime necessity to comfort, health, and even to life. There is no substitute for it. No question of economy or choice enters into the matter. Every man must have it and the need will perish only with the race. The only point common to water and gas supply is that each is taken by the user as wanted from an opening upon his own premises, the openings being connected to a common store through pipes laid in the streets."

If on account of disturbance of streets and pavements gas companies ought to be owned by municipal corporations, so also should street railway, electric, telephone and pneumatic tube enterprises. It is denied that cites have such an interest in gas lighting as justifies ownership. In many of the large American cities electric lighting is now substituted for gas, and

this substitution is annually increasing and extending even to small towns.

That public ownership tends to purity and efficiency in administration of public affairs, is, in the light recently shed upon the manner in which the people have been robbed by city governments, so palpably absurd, that it seems hardly necessary to be refuted. Yet to it a conclusive answer is found. "If corruptible men are in charge of our public affairs, a change from private to public, or from public to private ownership merely changes the form of the temptation to corruption. The one means to purity in public as in private business is purity in the men intrusted with its conduct. Dishonesty found its opportunity before Stevenson or Murdock were born, and cannot be deprived of it by a change of ownership of railroad or gas properties."

As to renewal of oppressive charges and cheaper manufacture by municipalities it is answered that "A municipality may reasonably exact from the gas company valuable concessions in return for assured exemption from gas competition. Such an arrangement insures the maximum of advantage to both municipality and company. A number of admirable systems are in actual operation." The idea of a revenue from the sale of gas is denounced as directly repugnant to all ideas of equity. "Municipal works being run as their advocates generally say they should be, for the purpose of cheapening gas, the gas must in equity be sold at its cost, including interest, charges, etc., the city paying the gas works account for all the gas used for public illumination." As to interest on money borrowed for the erection or purchase of works, the city as a borrower would have no advantage over a private company guaranteed against competition.

Professor Bemis cited the city of Wheeling as "the most conspicuous example of success in municipal ownership." The facts are that in Wheeling gas sells for 75 cents per thousand cubic feet. According to the books, it costs 43.7 cents delivered to the consumer. The depreciation, interest for taxes, must be included in a statement of actual cost. Mr. Clark accepts Prof. Bemis' estimate of depreciation as 2 per cent. Taxes are 1.2 per cent. These are estimated upon the structural value of the plant, which Prof. Bemis states was $380,000.

"Interest must be figured on the investment, sworn to by the superintendent at $800,000. With the entire credit of the city of Wheeling as security, its bonds bear interest at from 4½ per cent. to 6 per cent; 5 per cent. would be certainly within bounds for gas works bonds." The sum of these various charges amount to 45.1 cents per thousand cubic feet and it is clearly shown that when this is added to the actual cost of the gas, the latter costs about 14 cents per one thousand cubic feet more than Wheeling gets for it.

Irrigation by Sewage.

THE city sewage of Trinidad, Colorado, is disposed of for irrigation of arid districts in the neighborhood. This is the first attempt of the kind yet made in that state and a description of it is given by Mr. Norvel W. Wall, in the *Annual of the American Society of Irrigation Engineers* for 1892-93, recently issued.

The question of this kind of sewage disposal was under consideration during a considerable period prior to its adoption. When "the accumulation of filth became an unbearable nuisance," it was at first proposed to discharge sewage into the Las Animas river which runs through the city. This is a comparatively small stream, and as farmers below the city are obliged to resort to it for supplies of potable water, the idea of making it a vehicle for the sewage of the town was abandoned. Mr. Wall having been appointed advising engineer of "a committee with power to report a practicable system of sewage," made the necessary plans and sewage for the irrigation systems. In his report he said:

"Irrigation by sewage means the application of liquid sewage to the lands with the view of intercepting the fertilizing constituents. We all know the necessity of irrigating for the production of crops in this section of the country. In order to utilize the sewage for this purpose, it would be obligatory on you to procure a farm some distance below the city, where

the sewage could be conducted and there utilized, or the city could make contracts with one or more farmers to receive the sewage from the city. In my opinion, it would enable them to raise large crops and thereby constitute a revenue and not a tax. This method prevails both in England and continental Europe, and has been found to be practicable, and in many cases a financial success."

The system having been thus strongly recommended to the committee, as a complete solution of the problem of sewage disposal for the city of Trinidad, it was adopted; but a serious obstacle was met at the outset. "The plan appeared to the western farmer to be an innovation, and it seemed impossible to make a contract for any reasonable price, no one wishing to experiment with what was feared would become a difficult undertaking." In this emergency "Hon. James M. John, then mayor of the city, agreed to take care of the sewage for five years," and the scheme was carried out under this contract.

An outlet sewer conveys the sewage to the lands of Mr. John. This is constructed of eighteen-inch vitrified sewer pipe laid to a grade of two-tenths of a foot per hundred feet, or 10.56 feet to the mile; the sewer having a velocity of 2.58 feet per second when running full. The Las Animas river is crossed by an inverted syphon under the river bed made of 16-inch cast iron water pipe, having a masonry catch basin at either end. This syphon has a velocity of 4.68 feet per second when running full, a high velocity being necessary to keep the syphon from choking. A masonry chamber or tank is constructed at the mouth of the outlet sewer, and from thence the sewage is conducted to the several basins or reservoirs constructed by Mr. John. The lands are well situated for the purpose of irrigation; sloping toward the south and the Las Animas river from 2.5 feet to 3.5 feet in one hundred." These lands have been terraced and the sewage is conducted from the higher levels or terraces to the lower through wooden sluice-boxes, and the entire tract will be seeded to blue grass. "The sewage system will have, when completed, automatic flushers at the head of each lateral. The sewage is well diluted by the time it reaches the outlet, very little solid matter remaining.

"An obstacle to this plan in the eastern states and northern Europe, is the water contained in the sewage, these countries having already sufficient moisture for their crops, in some places the water being so plentiful that it is necessary to adopt a system of subsoil drainage to conduct away the surplus water. On the contrary, the object of the western farmers is to retain all the water possible. The objects of the states and countries using this system are a sanitary measure, and fertilizing the land. In the west we not only get rid of what would otherwise prove a detriment to the health of the community, and perhaps the pollution of our streams, but also gain an amount of water that would otherwise be lost, particularly in the season when our natural streams are at their lowest."

It is expected that when the system thus inaugurated has been completed it will bring into cultivation a large tract of land that has hitherto been unproductive.

Essential Qualities of Paving Brick.

AN article from the *Clay Worker* (London, Oct.) reprinted in *Paving and Municipal Engineering*, calls attention to defective specifications for brick pavements. A common specification is that "the brick must be hard, free from defects of any kind, manufactured and burned especially for street paving purposes, equal in all respects to the sample filed with the proposal, and subject to inspection, acceptance, or rejection by the engineer or inspector.

"With our present knowledge of this material, this phraseology may be accepted, but in reality it specifies very little. Its acceptance or rejection by an engineer is ordinarily regarded by the corporation as a safeguard, but no parties entering into a contract can place a power that is wholly arbitrary and undefined in the hands of an engineer, who is in reality the executive agent of one of the parties. Because bricks have been manufactured and burned especially for street paving purposes, it does

not necessarily fit them for such use. The term 'hard' is an indefinite one, and without stating what constitutes defects, there may be differences of opinion as to whether or not they exist in a given article, as well as to the equality of goods furnished with sample exhibited. Even sample paving bricks have been known to be worthless for street paving. The characteristic qualities and strength of the material are not clearly set forth as they should be. The power to accept or reject is left undefined, which should never be the case; neither manufacturer, bidder, nor taxpayer should be bound by the action of an engineer, unless that action shall be in accordance with known provisions and fixed rules."

The fault in specifications for street paving materials here pointed out is general in specifications for other kinds of municipal work, and specifications that do not specify are common enough in all kinds of contract work, whether in municipal or other departments of engineering.

It is not deemed advisable to specify ingredients too definitely on account of the wide variations in clays from which good paving bricks can be made. What ought to be definitely specified are the qualities required. However, the presence of lime can be readily detected, and specifications may properly exclude lime. The quality of absorbing water ought to be limited to the lowest point that can be specified without exclusion of bricks known to be otherwise good. Two per cent. is the maximum absorption that should be allowed. Minimum specific gravity ought to be as high as 2.1, "with credit for excess"; and a suitable maximum would be 2.3. Crushing strength should not be less than "12,000 pounds per square inch." Modulus of rupture, as determined by tests of transverse strength "could be properly fixed at 1600." In abrasion tests the loss of weight by the brick should not be more than 2.25 times that of hard granite.

"Uniformity in size and texture appears to be attainable, and lack of it produces many undesirable difficulties. Wide variations in size result from faulty drying and burning. We must either specify how the drying of the brick and the firing of the kiln shall be done, or describe what we want as the product of the kiln, and insist upon getting it. In the present state of our knowledge, the safer plan will be to name the requirements, and leave the manufacturer to wrestle with the details."

INDEX TO LEADING ARTICLES.

The journals quoted are indicated by initials, and their full titles are given in the opening pages of the Review. Other abbreviations are, Ill=Illustrated; W=Words.

Gas Supply.

*25785. Mr. George Livesey on the Inception and Development of Gas Lighting, with Editorial (J G L-Oct. 2.) 8000 w.

*26027. Inaugural Address of Colonel Sadler (J G L-Oct. 9.) 4000 w.

*26028. The Price of Gas in London.—Important Conference of Vestrymen (J G L-Oct. 9.) 3200 w.

26200. The Invention of Water Gas. Ill. (Sc A S-Oct. 27.) 1000 w.

26240. Products of Combustion from Argand and Welsbach Burners (A M & I W-Oct. 26.) 600 w.

26288. Regenerative Benches. A. E. Forstall (A G L J-Oct. 29.) 3000 w.

26289. Public Ownership of Gas Properties. Walton Clark, with Discussion (A G L J-Oct. 29.) 6000 w.

26455. Observations on Sunday Methods of Making Water Gas from Bituminous Coal. Ill. Mr. Egner, with Discussion (A G L J-Nov. 5.) 5500 w.

*26507. A Contribution Towards the Statical Calculation of the Guide-Framing of Independent Gasholders. Ill. M. Niemann (J G L-Oct. 23.) 4000 w.

Sewage.

25845. The Wentworth Avenue Trunk Sewer, Chicago, Ill. (E N-Oct. 11.) 1700 w.

*25917. The Pollution of the Aire and the Calder. Editorial (E-Oct. 5.) 2700 w.

*25924. The Utilization of Town Refuse for Generating Steam. (Abstract.) T. W. Baker, with Discussion (I & I-Oct. 5.) 2200 w.

†26074. Utilization of Sewage for Irrigation Purposes. H. I. Reed, with Discussion (A S I E-1892-93.) 2000 w.

*26213. Manchester Main Drainage. Ill. William Thomas Olive (E-Oct. 19.) 6000 w.

26394. The Merz System of Garbage Utilization in Four American Cities. Ill. (E N-Nov. 1.) 9500 w.

*26426. Brussels' Sewage System. Ill. Gibson Thompson (P-Nov.) 3500 w.

We supply copies of these articles. See introductory.

INDEX TO LEADING ARTICLES.

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26625. The Paris Sewers and Sewage Farm. William P. Mason (E N-Nov. 8.)600 w.

Streets and Pavements.

*25279. Street Paving in Sheffield (B A-Sept. 7.) 1800 w.

25846. Property Assessments for Street Improvements. Editorial (E N-Oct. 11.) 2000 w.

25860. Street Paving in Western Cities (E R-Oct. 13.) 1800 w.

26001. Street Paving and Watering in Boston in 1893 (E N-Oct. 18.) 1100 w.

*26034. Asphalt Pavements. S. Whinery, with Discussion (J A E S-Sept.) 10000 w.

26279. Specifications for Roads and Sidewalks, Boston Public Parks (E R-Oct. 27.) 1000 w.

*26391. Cleaning the Streets of Paris. Henry Smith Williams. (From Harper's Weekly.) (C A-Oct.) 3200 w.

*26425. Cohesive Strength of Asphalt. F. N. Speller (P-Nov.) 900 w.

*26428. Essential Qualities of Paving Brick (P-Nov.) 1800 w.

Water Supply.

25798. The New Croton Dam on the Cornell Site. Ill. (Sc A-Oct. 13.) 1600 w.

25843. New 30,000,000—Gallon Pumping Engines, Philadelphia Water-Works. Ill. (E N-Oct. 11.) 900 w.

25947. Filter at the Wannacomet Water-Works, Nantucket, Mass. Ill. (F. W-Oct. 13.) 1600 w.

26003. The Dunning's Dam, Scranton, Pa. E. Sherman Gould (E N-Oct. 18.) 1800 w.

*26036. Covered Reservoir at Rockford, Ill. Ill. Charles G. Stowell (J A E S-Sept.) 2000 w.

*26052. The Leicester Water "Famine" (E-Oct. 12.) 4000 w.

26064. Delaware River Water for Philadelphia, Pa. (E R-Oct. 20.) 800 w.

26065. Test of the Louisville Pumping Engine. Ill. (E R-Oct. 20.) 3500 w.

†26121. The Hesserghatta Water-Supply. Ill. R. T. S. (I E-Sept. 22.) 1700 w.

26179. Manchester Corporation Water-Supply. The Inauguration of the Thirlmere Works (J G L-Oct. 16.) 3800 w.

†26231. The Quality of Water Supplies. William P. Mason (J A C S-Nov.) 1200 w.

25259—$1. Frontinus and His Two Books on the Water Supply of the City of Rome (A E C U-1894.) 16000 w.

26276. The Water Supply of Two Cities. John W. Hill (E R-Oct. 27.) 1900 w.

26278. Sing Sing, N. Y., Water-Works. Ill. (E R-Oct. 27.) 1600 w.

26327. Electrolyzed Water Pipes in Omaha. Joseph Rigge, Sr. (F W-Oct. 27.) 1700 w.

26348. The Water Supply of New York City.—The New Carmel Dam and Reservoir. Ill. (Sc A-Nov. 3) 1000 w.

*26445. The Thirlmere Water Supply. Ill. G. H. Hill (E Rev-Oct. 20.) 900 w.

26479. The Water-Works of Naples (A A-Nov. 3) 900 w.

*26515. Water Supply. Henry Robinson (Eng L-Oct. 26.) 1300 w.

†26531. The Pollution of Water Supplies and the Results of Filtration.—Report of Committee. Charles Smart, Chairman (San-Nov.) 5000 w.

26608. The New Dam for the Chemnitz Water Works. Ill. (Sc A S-Nov. 10.) 450 w.

26612. Report on Duty and Capacity Trial of Worthington Pumping Engine at Low Level Pumping Station, Montreal Water Works. J. T. Nicolson and J. Emile Vanier (C E N-Nov.) 1400 w.

Miscellany.

*26033. Typhoid Fever and the Epidemic at Ironwood, Mich., in 1893. E. A. Rudiger (J A E S-Sept.) 5000 w.

*26100. Sanitation in Liverpool. Presidential Address of G. F. Deacon. (Abstract.) (A L-Oct. 5) 2500 w.

†26157. The Chemistry of Cleaning. Vivian Lewes (P S M-Nov.) 5800 w.

†26499. Excavation and Disease (I E-Sept. 29.) 500 w.

*26517. The Disposal of Town and Other Refuse. Ill. James Deas (E E L-Oct. 26.) 1500 w.

26626. The Proposed Drainage System for New Orleans (E N-Nov. 8.) 1800 w.

Serials.

23641. Details of Rural Water Supply (B-Began July 7—17 parts to date—30 cts. each).

24751. The Gas Manager Abroad (G W-Began Aug. 25—7 parts to date—30 cts. each).

25117. Remarks on the Gas Industry in America. H. Bunte (P A-Began Sept. 15—Ended Oct. 15—3 parts—15 cts. each).

25179. The Water Service and Fire Protection of Theatres. William Paul Gerhard (F W-Began Sept. 15—Ended Nov. 3—8 parts—15 cts. each).

25347. About Water Gas. Edwin A. Doron (G E M-Began Sept.—2 parts to date—30 cts. each).

25898. Oil Gas. W. A. Noyes, W. M. Blinks and A. V. H. Mory (A M & I W-Began Oct. 12—2 parts to date—15 cts. each).

26096. Notes on Modern Gas Making Plant (I & I-Began Oct. 12—2 parts to date—30 cts. each).

26221. The Manchester Thirlmere Water-Works. Ill. (Eng L-Began Oct. 19—1 part to date—30 cts).

26436. Gas Manufacture. J. J. Johnson (C T J-Began Oct. 27—1 part to date—30 cts).

We supply copies of these articles. See introductory.

RAILROADING

Reasonable Railway Rates.

A PAPER occupying 26 pages, with numerous tables of statistics chiefly compiled from the Reports of the Interstate Commerce Commission, by H. T. Newcomb, appears in the *Annals of the American Academy of Political and Social Science* for November. The purpose appears to be to correct in the minds of the public some erroneous views prevailing with reference to railways, and to show not only that the tendency of rates has been, and is downwards, but that this must continue until the level of reasonable rates is everywhere reached.

"There is great danger of forgetting, at least temporarily, that the only adequate cause for the prevailing widespread dissatisfaction with the methods adopted by those officially in charge of railway properties, and the relations between railway corporations and their patrons is public discontent resulting from the charges exacted for railway transportation. Railway men are perhaps sometimes justified in the use of the term 'confiscatory legislation' even as applied to what 'are in reality honest, although often mistaken, attempts to secure to the public by legislative action more satisfactory rates.' Many statutory regulations have not only failed of good effect, but have absolutely wrought evil.

"Upon the other hand, an important section of the press and many popular leaders are constant and vehement in their attacks upon the so-called evils of over capitalization, stock watering, unnecessary construction, improvident and wasteful management, consolidations, agreements to maintain rates or divide traffic, etc., which, even if serious evils in themselves, can only operate injuriously upon a limited number of individuals, unless their effects extend to the charges for transportation."

"Popular dissatisfaction with railway charges does not arise from the fact that they are universally or even generally excessive. Railway rates in the United States are generally lower than anywhere else in the world, much lower than they were here five, ten or fifteen years ago, and quite as low as is consistent with the maintenance in an efficient condition of road-bed and equipment, the payment of fair wages, and even approximately adequate return to the capital invested."

The reduction of rates during the six years of operation of the interstate commerce law, are stated to have saved the public during the year ending June 30, 1893, no less than $149,405,511, "an amount exceeding by nearly $50,000,000, the total of all the dividends paid on railway stock, and equal to seventy-three per cent. of the entire customs revenue of the United States government during that year."

Mr. C. C. McCain, auditor of the Interstate Commerce Commission, is quoted as asserting that "from all forms of comparison presented, it is clearly demonstrated that there has been a constant downward tendency in freight charges in all sections of the country." A statement of rates charged for transportation of grain by all lines from Chicago to New York, confirms the assertion of Mr. McCain.

RATES IN CENTS PER 100 POUNDS.

Year	Jan. 15.	April 15.	July 15.	Oct. 15.
1864		75	80	95
1869	75	50	50	50
1874	60	40	45	45
1879	35	20	22	35
1884	30	15	20	25
1889	25	20	20	25
1894	25	20	20	25

In 1873 it cost $4.05 per gross ton to transport coal from the Clearfield region of Pennsylvania to Jersey City; whereas it now costs $2.25. In 1881 it cost 74 cents per bale to transport cotton from Memphis to New York; last year the rate was constant at 50½ cents. Whereas

freight upon starch from Boston to North Adams was 38 cents per 100 pounds in 1874 (Boston and Albany railroad), it is now 15 cents. This last is cited as indicating that local rates have in many instances declined in greater proportion than competitive rates; it is not a solitary instance.

"Examples of reduction equal in extent to the foregoing, including all sections of the country and every article of commercial importance commonly offered for shipment by rail, might be multiplied indefinitely." This tendency toward lower rates is thus proved to have been a marked characteristic of railroading in the United States.

When the cause for this reduction is sought, it is implicitly, if not explicitly denied that it has been "grudgingly yielded by reluctant carriers who have succeeded in retaining rates sufficiently high to yield extortionate and unreasonable returns upon the capital invested." As opposed to this view, stands the principle that only in exceptional and rare cases is it possible to maintain excessive rates.

"The interest of the railways and their patrons both unite in the creation of conditions against which it is vain for any railway official to contend for extremely high rates." High rates may be carried to a prohibitive extreme, and the law of competition acts with railroads as in all other kinds of business. "A large traffic at low rates is often more profitable than a smaller traffic at higher rates." Low rates promote industrial development along lines of railway, and this reacts upon the roads to increase their business. "An enlightened consciousness of these facts has caused the great majority of railway officials, having authority to make rates, to concede to their patrons the lowest rates that could be made without increasing expenses faster than gross revenue." The average financial condition of the roads also proves that they have not been able to exact excessive rates. Sixty per cent. of their aggregate revenue is required to pay cost of operation, including wages, repairs of road-bed, equipments, etc., three per cent. is paid in taxes, leaving only "twenty-seven per cent. to be distributed among those who furnish capital, for use in making permanent improvements, and surplus for future contingencies." Tables of receipts and expenditures, carefully compiled, prove this fact.

As to watered stock, it is held that "instances of substantial reduction of capitalization resulting from mortgage foreclosures, are numerous enough to create considerable confidence that they may entirely balance the water... During a period of eighteen years, from the beginning of 1876 to the close of 1893, 551 railway corporations, operating 57,283 miles of road, with stocks and bonds amounting to $3,209,126,000 were sold under foreclosure. This tremendous insolvency with resultant sales under the hammer of the auctioneer may easily have resulted in wiping out an amount of stocks and bonds little, if any, less than that created by watering."

But while it appears that railway rates are not excessive, the unjust discrimination in rates which has found its way into railway transportion, is deleterious to industrial prosperity, and this more than anything else, or all else put together has raised the popular outcry for legislation regulating traffic. The aggregate rates not creating excessive revenues to the roads, there are still unjust and inequitable conditions which must be removed to satisfy the reasonable demands of the public. The conclusion is thus reached that it is quite as important "that the adjustment of rates shall be made without unjust discrimination against persons, places, or classes of traffic, as that the charges shall not be excessive... Reasonable and proper discriminations, based upon the value of service performed, are essential and should continue." The carrier's revenue should be made "the sole criterion of charges, subject to the single limitation that rates must be open to all."

Responsibility for Joint Tariffs.

THE recent order of the Interstate Commerce Commission is made the subject of editorial criticism in *The Railway Review* (Oct. 13), or, more strictly, the reasons

assigned by the commission for promulgating the order are considered as defective and unsatisfactory. This view is more particularly taken of the following clause, relative to joint tariffs.

"When such a tariff is filed by one of the associated lines only, as is usually the case, if the participating carriers are not designated and no proof of their concurrence is furnished, it is quite possible for the latter to avoid liability when charged with criminal misconduct in respect of a joint rate so issued, by denying knowledge of its existence or consent to its publication, although the fact that they carried traffic apparently under that tariff may be clearly established. If a connecting carrier, which joins in the transportation of freight received from the initial carrier is prosecuted for violating the joint rate published by that initial carrier alone, there can be no conviction without proof, often impossible to obtain, that such connecting carrier agreed to the joint rate in question or authorized its promulgation. On the other hand, if it is assumed that the connecting carrier is not a party to the joint rate so issued, for want of assent thereto or concurrence therein, and the charge of unlawful conduct is based upon the acceptance of less than its own local tariff, such connecting carrier may refute the accusation by asserting that it had consented to the joint schedule issued by an initial carrier, and was in fact a party thereto. Thus the ground of defense can be shifted to meet the theory of the prosecution, and a given carrier actually guilty of wrongdoing may secure immunity from punishment through inability to determine, before its disclosure is forced, whether it is or is not bound by the joint tariff which another carrier has published and filed."

Of this the opinion is expressed, that "while it is important that the identity of parties to a joint tariff shall be susceptible of proof in court, it is not clear that under the decision of the commission such a condition will be established." The assumptions of the commission "that the carrier which publishes a tariff of this kind would ordinarily send copies of the same to all other carriers expected to participate in the joint service thereby announced" and "that it must be entirely feasible for the carriers receiving such a tariff to forward to the commission official notice that they consent thereto," are regarded as incorrect. The Wabash road is instanced in this connection as the one on which "the very difficulty sought to be removed by the order in question was experienced."

"The Wabash road may issue a tariff from East St. Louis to various eastern points. This tariff is not issued for the purpose of advising its connections of the rates under which property is to be carried, nor is a copy of it as a rule, if ever, sent to even its immediate connections, to say nothing of subsequent carriers. It is issued as an advertisement pure and simple, and is designed for distribution among its patrons. The document so issued in the sense that it determines the rate is of no force whatever. It is simply an advertising notice to the public of what the rate is, of a character identical with any other advertisement, the same as if published in the advertising columns of a newspaper. The advice to participating lines as to rates in effect is conveyed to them in an altogether different way, and not by the Wabash road at all, although that road would expect and would be justified in expecting that any line participating in the business would accept its proportion of the current rate without any direct notice from itself."

Another assumption of the commission disputed is that "such tariffs necessarily imply an agreement between two or more carriers by virtue of which they offer their united services at the rates therein named"; also the assertion is made in this connection that these agreements are not made in writing but that they "almost invariably rest in parole." On the contrary, it is asserted on the part of the *Review* that so far from contracts for interchange of business being usually in the nature of parole agreements, they are made in writing, and "are usually arranged with the utmost care and particularity."

A caution is given to those who entertain the idea that no penalty can attach to the failure of a road to comply with the

order. "A writ of injunction to restrain from receiving or transporting property any common carrier who shall neglect or refuse to file or publish its schedule of rates, fares or charges, as provided for in section six, may be served upon roads which do not meet the requirements, and the same section also provides that the commission "may determine and prescribe the form of schedules." In view of all aspects of the question it is advised that "the roads make a sincere attempt to comply with the requirements and rely upon the admitted fairness of that body to reconstruct its order as soon as it shall be found that the present regulation is not effective."

The Permanent Way of the Pennsylvania Railroad.

"ENGINEERING" (London) in its issue of October 26 has published a long article on the above named subject, in which not only the general character of the permanent way is considered, but its details are gone into with abundant illustrations. A very high encomium upon the engineering management of this great road is bestowed.

"Although at the present time there are not a few railways in the United States for which may be fairly claimed a place in the front rank, even when judged by the highest standard, for efficiency in construction and for equipment, it will, we suppose, be freely recognized that it was the Pennsylvania Railroad Company which initiated the progress that has converted the railway system of America from being a rough and somewhat unready means of transport to the high-class system that it is to-day. From its earliest days—and the organizers of this now great and powerful company were among the pioneers of railway construction in America—the motto of the Pennsylvania railroad has been "Advance." Nearly twenty years ago we published in these columns a long series of articles, from which the English readers learnt for the first time what was the most advanced railway practice of the period in the United States. Were we again to undertake a similar task we should once more select the Pennsylvania railroad as our type of the highest development, for we consider that it has in all respects maintained the lead which energy and skill secured for it at least half a century ago."

Not only the details of the permanent way, but the business methods of the engineering department in getting work and materials up to their present high standard are favorably considered. The standard specification for steel rails is an exemplification of these methods. Probably nothing more thorough in the way of specifications exists. Every structural, physical and chemical quality desired is so explicitly stated that no chance for any disagreement as to the meaning of each requirement can be made by manufacturers who undertake to supply the rails. There are ten clauses specifying these requirements, four which state defects that will cause temporary rejection, and four which state causes for permanent rejection. Standard rail-sections are illustrated with dimensions of flange, web, and head.

Specifications for road-bed, ballast, crossties, line and surface of track, joints, gage, switches, sidings, ditches, and road crossings, have all been prepared with equal care and minuteness. The numerous diagrams of details together with the descriptive text form an exposition of one of the best existing examples of general railway practice, of technical value to railway engineers and others in any way connected with the construction and maintenance of railways.

A Dynamometric Car.

ON the Western of France Railway is what is called a dynamometric car of which *The Engineer* (London) has given an illustrated description. This car well exemplifies the refinement of modern engineering methods in testing the action of machines. By its use the tractive effort, total work, speed, number of revolutions of wheels, time of running, distance run, etc., are determined, which, together with the weight of fuel consumed, ascertained by weighing, water evaporated, which may also be determined either by weighing or measuring, and an analysis of the products

of combustion, constitute a complete set of data for determination of the mechanical and economical efficiency of any locomotive to which the dynamometric car is attached.

"The car is carried upon two axles and a special coupling arrangement is employed to eliminate the influence of curves while permitting the buffers to make contact; for this purpose the buffers are connected to a transverse bar which rests at the center upon a group of rubber washers. Upon the platform at the end of the car a trap door is arranged, so that the dynamometer may be readily put in or out of gear. At each side of the entrance door is a raised seat, from which an attendant can observe the train, track, and locomotive, and have within reach electric press buttons to note upon the diagrams particular points upon the roads, also a speaking tube to the locomotive, and apparatus for the purpose of collecting gases from the chimney. Under the seats are arranged the Orsat apparatus for gas analysis.

"Outside the end windows are placed inclined plates to prevent the deposit of dust and soot upon the glass. In the center of the car is placed a table, upon which are collected all the recording apparatus described below. At one end of the vehicle there is a lavatory, and also a workshop in which any slight necessary repairs may be done while traveling. The car is heated by means of a small stove, and ventilation is assured by means of two Pignatelli apparatus, one opening above the end windows and the other in the ceiling of the central compartment. The results obtained in each particular trial are all recorded upon a single band of paper which receives its motion from the axle of the car, and is unrolled continuously during the journey proportionally to the distance covered. All the recording apparatus also is put into action by the car itself.

The determination of the tractive effort is made from a record of a pull on the draw bar, indicated by a tracing made on a strip of paper which moves under the point of a pencil, the latter being moved at right angles to the direction of motion of the paper by apparatus connected with dynamometer springs that measure the pull. The total work is automatically indicated by an apparatus provided for that purpose which saves the labor of computation. The speed of the train is automatically recorded by a tracing made on a revolving flat disk of paper, the motion of which, by ingenious mechanism, is made to harmonize with the speed of the train, the ratio between these being a constant. "The time is registered by means of a clock with electrical contacts by means of which a current is sent every ten seconds into a magnet that actuates a pencil." This therefore makes six marks per minute upon the paper band. The mechanism for tracing the datum lines, and effecting the movement of the paper band is ingenious.

"The analysis of the products of combustion is effected by two sets of Orsat apparatus placed below the observation seats. The analysis consists of measuring the percentage of carbonic acid, oxide, and oxygen. The residue is supposed to consist solely of nitrogen. A copper tube is suspended from the top of the locomotive chimney, and is connected by an india-rubber tube to a fixed flask into which the gas is drawn by an aspirator. The volume of gas to be analyzed is passed into a graduated tube, and then passed into test tubes containing absorbents. The first tube contains a solution of caustic potash, which absorbs the carbonic acid; the second contains a solution of potassium pyrogallate which absorbs the oxygen, and the third tube, a solution of cuprous chloride which absorbs the carbonic oxide. After each absorption the gas remaining is measured in the graduated tube, and the volume absorbed is the difference between the first and last measurements. The final residue is considered as nitrogen."

This car was first exhibited at the Paris Exhibition in 1889, and attracted much attention there. Since that time two others have been built. Renewed interest in the subject of locomotive testing has been excited by the application of this apparatus to a test of the Heilmann electric locomotive for the determination of its tractive power and speed, which machine is further mentioned in department of Electricity.

Locomotive Building in Russia.

RUSSIA as compared with other powerful nations presents the anomaly of a government quick to seize upon any modern improvement calculated to augment her military power, yet slow in the encouragement of arts which lead only to the social elevation of the masses of the population. Thus behind other nations in agriculture, and, generally speaking, in mechanic arts, she was one of the first continental nations in which railways were introduced. The first railway line constructed in Russia was from St. Petersburg to Zarskoje Selo, opened for traffic in 1838. At that time railroading both in England and in America was in its infancy, so that Russia was not much behind in recognition of the practical advantages which have resulted from railway communication. Since that time, while in other countries the extension of railway traffic has been with a view to extension of commerce, in Russia military considerations have been of equal or greater influence in determining where and when railroads should be built.

Following up the history of Locomotive Building in Russia *The Railway Press* (London) finds its beginnings in 1844, when the government undertook the construction of the Nikolai railway. It then leased the Alexandrow Works to an American company for the manufacture of the rolling stock of that road. But it is alleged that this company did not really manufacture locomotives or, at least, did very little manufacturing in the Alexandrow works except the erection of parts manufactured abroad and imported.

Towards the seventies the government once more attempted to establish the manufacture of locomotives as a home industry. "In 1866, an imperial ordinance was issued that in future all state contracts should be executed in Russia, whatever difficulties this might entail in the first years."

"Loans were consented to by the government for the construction of new works, or the enlargement of those already extant. Premiums were to be paid for promoting manufacture. The right of private railways to order from abroad was restricted, and import duties raised. At first the government did not think it wise to support more than three locomotive manufacturers, and promised to order from each of them fifty locomotives, to be delivered in the course of five years. The price of each passenger engine per ton was to be 775 roubles, and 750 roubles for goods engines. The weight according to which the price was reckoned was that of the empty engine. A sum of 300,000 roubles would be lent to manufacturers on mortgage. Finally, those who could obtain orders from private railway companies would receive premiums.

"Two large works, Malzew, in Brjansk, and the Newski, availed themselves of these offers. The Putilow and Baltic, in St. Petersburg, did not, however, enter into any arrangement with the government. Later on the Kama Wortinski received an order for eight locomotives, in accordance with the above conditions. At the same time the well-known Kolomna Works began to construct locomotives.

"The following table gives an idea of the progress of locomotive building in Russia:

Year.	Number of engines built in Russia.	Built abroad.
1867.....	217	790
1876.....	794	2470
1883.....	1490	790
1891.....	1105	....
Total at end of 1891,	3606	4050

"Thus at the end of 1891, out of a total of 7656 engines, 4050 or 53 per cent. were built abroad."

During the most active period in Russian railway building she could only supply 27 per cent. of the locomotives required. Since 1876 half of the locomotives required have been of home construction which is, at least partly, attributed to increase of import duty. A table of duties from 1876 to 1891 inclusive, is given. Prior to 1876 the duty was 1 rouble per poud. (A rouble is equal to $0.748 dollar U. S. and a poud is 36 pounds avoirdupois.)

The duty was increased in 1876 to 1¼ roubles per poud. From 1877 to 1881, it was 1¼ per poud on locomotive alone

and $\frac{1}{8}$ rouble per poud on tender alone. In 1881 the duty was further increased to 1.375 roubles per poud on locomotive alone. From 1881 to 1887, it was 1.4 roubles per poud on locomotives alone, and 0.9 rouble on tender alone. From 1887 to 1891, the duty was 2 roubles per poud on locomotive alone, and 1 rouble per poud on tender alone. Since 1891 the duty has remained 2 roubles on locomotive alone but has been increased to 1.7 rouble on tender alone. On a locomotive weighing, say, 40 tons the duty would now be 4444 44 roubles which would at first sight seem to be prohibitive provided the cost of building a locomotive in Russia does not very much exceed that of other countries. It has not, however, proved wholly so, as locomotives are still imported to some extent. Activity now prevails in all Russian locomotive works, being stimulated by the construction of the great Trans-Siberian railway, which with necessary renewals, is likely to keep up this activity for a considerable period.

INDEX TO LEADING ARTICLES.

The journals quoted are indicated by initials, and their full titles are given in the opening pages of the Review. Other abbreviations are, Ill=Illustrated; W=Words.

*24306. La Guaira and Caracas Railway. E. H. A. Heinke (R P L-Aug.) 1500 w.

*25793. Locomotive Building in Russia: Its History and Development. Mernok (R P L-Oct.) 1400 w.

*25794. The Origin of the Railway System (R P L-Oct.) 2000 w.

*25826. Midland and Great Northern Joint Railways New Passenger Engines. Ill. Clement E. Stretton (R W-Oct.) 400 w.

*25827. An English Light Railway. Ill. (R W-Oct.) 1400 w.

*25829. The Theory of Railway Engine Motion. Clement E. Stretton (R W-Oct.) 1100 w.

25830. Friction and Brakes. Editorial (R C J-Oct.) 1800 w.

25832. Electricity—Its Application in Car Construction, Lighting Cars and Shops. Duane Doty (R C J-Oct.) 3600 w.

25833. Collar and Collarless Car Axles (R C J-Oct.) 2500 w.

25850. Rocky Mountain Work on the Great Northern. Ill. J. H. Kennedy (R G-Oct. 12.) 5300 w.

25859. Erection of Boston and Maine Train-Shed Roof. Ill. (E R-Oct. 13.) 1600 w.

25902. Responsibility for Joint Tariffs. Editorial (R R-Oct. 13.) 1800 w.

*25915. Indian Railway Development. Editorial (E-Oct. 5) 2700 w.

*25919. Early Tramroads and Railways in Leicestershire. Clement E. Stretton (E-Oct. 5.) 1200 w.

*25935. The Working of the Railways. Editorial (Eng L-Oct. 5.) 2000 w.

*25936. A Dynamometric Railway Car. Ill. (Eng L-Oct. 5.) 2500 w.

26009. Handling Freight Trains with Air Brakes. F. M. Neilis (R G-Oct. 19.) 1500 w.

26010. An English Achievement in Excursion Traffic (R G-Oct. 19.) 1400 w.

26012. Enlargement of the North Eastern Railway Station at Newcastle, England. Ill. C. H. G. (R G-Oct. 19.) 800 w.

26014. The Industry of Train Robbing. Editorial (R G-Oct. 19.) 900 w.

26015. Pensions and Relief Funds for Railroad Men. Editorial (R G-Oct. 19.) 2800 w.

26023 Railroad Locomotive Boiler Inspection on the Central Railroad Company of New Jersey. Ill. (S V-Oct. 15.) 800 w.

26101. Report of Committee on Railway Signalling (R A-Oct. 19.) 1000 w.

26106. Car Sanitation. G. P. Conn (R R-Oct. 20.) 3000 w.

26108. Minor Railroad Economies. Editorial (R R-Oct. 20.) 800 w.

26109. Master Mechanics Association Standard Boiler Steel Specification (R R-Oct. 20.) 1700 w.

*26158. English Railroad Methods. Ill. H. G. Prout (Sc M-Nov.) 7000 w.

26184. Long Valve Travel and the Locomotive. "J. W. Miller." Letters and Editorial (R G-Oct. 26.) 2700 w.

26186. Lehigh Valley Coal Storage Plant at West Superior. Ill. (R G-Oct. 26.) 700 w.

26187. Passenger Rates in England and America. W. M. Acworth (R G-Oct. 26.) 1500 w.

26188. Coupler Tests at Chicago. Editorial (R G-Oct. 26.) 1700 w.

26193. The Air-Brake Patent Litigation and Its Lessons. Editorial (E N-Oct. 25.) 2200 w.

26194. The Air-Brake Patent Decision (E N-Oct. 25.) 1800 w.

*26208. Rack Railway in Japan. Ill. S. Kikkawa (E-Oct. 19.) 1700 w.

*26222. Great Northern Railway.—Works in Connection with the Widening of the Line at King's Cross. Ill. (Eng L-Oct. 19.) 1000 w.

*26223. The Inspection of Railway Bridges in India. Editorial (Eng L-Oct. 19.) 2000 w.

*26224. Railroading in America. Ill. By an English Railway Engineer (Eng L-Oct. 19.) 2800 w.

*26307. The Amendments to the New Zealand Railway Act (Tr-Oct. 19.) 600 w.

26310. Some Inconsistencies in the Signaling

of Diverging Routes. C. C. Anthony (R R-Oct. 27.) 1200 w.

26311. Notes on Steel Sleepers. W. H. Cole (R R-Oct. 27.) 1200 w.

26312. The Air Brake Decision. Editorial (R R-Oct. 27.) 2200 w.

26313. Coupler Tests at the Works of the Chicago Tire and Spring Company (R R-Oct. 27.) 1200 w.

26314. Compound vs. Simple Engines. T. A. Fouque (R R-Oct. 27.) 1500 w.

*26360. Locomotive Injectors. George H. Baker (N C B-Nov.) 3000 w.

*26361. Piston Travel on Cars. F. B. Farmer (N C B-Nov.) 1800 w.

26401. New York City Rapid Transit. Ill. J. J. R. Croes (R G-Nov. 2.) 3200 w.

26402. The Puzzles of Rate-Making. Editorial (R G-Nov. 2.) 1800 w.

26403. Variation in Temperature in Locomotive Cylinders. Editorial. Ill. (R G-Nov. 2.) 3800 w.

*26404. A Trip to North Wales. Ill. A. S. (L E-Nov.) 2500 w.

*26405. Human Flesh and Blood as Steel Tempering Material (L E-Nov.) 800 w.

*26406. Frictional Resistance and Brake Efficiency. Editorial (L E-Nov.) 1500 w.

*26407. Inferior Boiler Tubes. Editorial (L E-Nov.) 1000 w.

*26408. Bunching Trains When Only Partly Equipped with Air. Will W. Wood (L E-Nov.) 1600 w.

26422.—$1. Reasonable Railway Rates. H. T. Newcomb (An A A-Nov.) 6000 w.

*26439. The Permanent Way of the Pennsylvania Railroad. Ill. (E-Oct. 26.) 2200 w.

*26442. The Railway Situation. Editorial (E-Oct. 26.) 1200 w.

26509. Owners of Cars Responsible for Defects. (Extract) J. N. Barr, with Editorial (R E M-Nov.) 2000 w.

26511. The Value of Compressed Air in and about Railroad Shops. Ill. F. M. Twombly (R E M-Nov.) 1100 w.

*26516. Locomotives and Trains. Editorial (Eng L-Oct. 26.) 1800 w.

*26545. The Hours of Labor of Railway Servants (Tr-Oct. 26.) 1500 w.

*26546. Railway and Waterway Competition on the Continent (Tr-Oct. 26.) 1200 w.

26548. Railway Rates in the Northwest. J. W. Kendrick (R A-Nov. 2.) 1800 w.

26549. The M. C. B. Coupler in 1894. Ill. A. M. Waitt (R A-Nov. 2.) 3700 w.

26550. Railway Work in Argentine. Ill. Benjamin James Forrest (R R-Nov. 3.) 600 w.

26552. The Law on Routing Freight. Editorial (R R-Nov. 3.) 900 w.

26553. Intelligent Use of Material. Editorial (R R-Nov. 3.) 1400 w.

26620. West Virginia's Connections with the Lakes. Thomas Bruce (M R-Nov. 9.) 2000 w.

26633. Guard Rails; Elevated Railroads. Ill. (R G-Nov. 9.) 400 w.

26635. A Minimum Gage Railroad. F. B. L. (R G-Nov. 9.) 1200 w.

26636. The Heilmann Locomotive. Editorial (R G-Nov. 9.) 3000 w.

*26642. Railway Servants' Hours of Labor. Report of the Board of Trade (R'y T-Oct. 27.) 800 w.

*26643. The Grand Trunk Railway Company of Canada and Its Saviours." Editorial (R'y T-Oct. 27.) 900 w.

*26644. The Colar Gold Field and the Treatment of Its Tailings. A Correspondent on the Field (Min W-Oct. 13.) 1800 w.

26653.—$1 50. On Form of Railway Excavations and Embankments. Ill. D. J. Whittemore, with Discussion (T C E-Sept.) 4800 w.

Serials.

15496. Railroad Coppersmithing. Ill. John Fuller, Sr. (L E-Began Sept. 1893—Ended Nov. 1894—12 parts—30 cts. each).

18435. Painting a Railway Passenger Car. A. Ashmun Kelly (R E M-Began Jan.—8 parts to date—15 cts. each).

22639. A Master Car Builder's Reminiscences. John Kirby (R C J-Began June—3 parts to date—15 cts. each).

22869. The Enlargement of Liverpool Street Station, Great Eastern Railway. Ill. (Eng L-Began June 8—5 parts to date—30 cts. each).

23719. The Early Railway Routes to Scotland. G. A. Sekon (R P L-Began July—4 parts to date—30 cts. each).

24266. Brakes and Brake Calculations (R C J-Began Aug.—2 parts to date—15 cts. each).

24621. Rules and Instructions for the Guidance of Railway Agents (R R-Began Aug. 25—10 parts to date—15 cts. each).

24809. Car Shop Economy. James F. Hobart (N C B-Began Sept.—3 parts to date—30 cts. each).

24938. Passenger Train Service in 1894 (Tr-Began Aug. 31—3 parts to date—30 cts. each).

25663. The Mushkaf Bolan State Railway (I E-Began Sept. 1—2 parts to date—45 cts. each).

25670. Special Shop Tools. Ill. (R E M-Began Oct.—2 parts to date—15 cts. each).

25674. The New Central Railway Station at Lisbon. Ill. (E-Began Sept. 28.—Ended Oct. 5—2 parts—30 cts. each).

25795. What Our Railways Might Have Been. G. A. Sekon (R P L-Began Oct.—1 part to date—30 cts).

26400. Railroad Legislation and National Prosperity. Don Alexander (R G-Began Nov. 2—2 parts to date—15 cts. each).

26525. The Liverpool Overhead Railway (E R L-Began Oct. 26—1 part to date—30 cts).

26554. The General Theory of Rates. Charles H. Cooley (R R-Began Nov. 3—1 part to date—15 cts).

We supply copies of these articles. See introductory.

STREET RAILWAYS

City Ownership of Street Railways.

UPON the municipal ownership of street railways, a subject which is just now being discussed quite generally, *Engineering News* expresses the view that what it styles "honest public opinion" is decidedly in favor of municipal ownership instead of indefinite private control of public streets. The point is also urged, that provision for ultimate municipal ownership should be made in the letting of all street franchises. The experiments in municipal ownership in Detroit, Mich., and in Toronto, Canada, are mentioned, and some particulars are given.

"The Toronto plan has succeeded in spite of the loud declaration of more or less interested parties that no corporation would even bid for a franchise so hedged in with conditions; and it now remains for other American cities to follow the example laid down. As a rule, street railways are very profitable enterprises, there is no reason at all why the city should not share in the profits after the traveling public is granted what it should have—the best service at the lowest cost.

"In Toronto the 30-year lease of the street railways expired in 1891, and the municipality exercised its privilege of purchase. The award was made by arbitrators in this case, and the sum paid was about $1,500,000. Instead of attempting to operate the lines itself the city concluded to again sell the franchise for a fixed period of time, upon terms more favorable to the people and to the public treasury. The terms of sale required the purchaser to compensate the retiring street railway owners to the amount of the purchase by the city; to pay rental per mile of $800 per annum for single track and $1600 per annum for double track, and to pay a percentage upon gross receipts from all sources, as follows: Up to $1,000,000 per annum, 8 per cent.; between $1,000,000 and $2,000,000, 15 per cent.; upon all gross receipts over $3,000,000 per annum, 20 per cent. The purchaser was further required to replace horse traction by electric power, and to build additional lines where and when the city council might direct under the supervision of the city engineer. The city expressly reserved the right to regulate the speed and service necessary and to determine that while the single cash fare should be 5 cents, tickets should be sold in packages at 25 for $1, or 6 for 25 cents. Workingmen's tickets, to be used at stipulated morning and evening hours, were to be sold 8 for 25 cents, and tickets for school children, good between 8 A. M. and 5 P. M., were to be sold at the low rate of 10 for 25 cents. Severe as were these terms, so unusual in the experience of modern street railway magnates, the franchise was sold in September, 1891, and the system is now in complete working order, with the city as the party chiefly benefited, both in the form of a cash return and the greater cheapness and convenience of traffic to its citizens.

"This charter, as we understand it, terminates after a period of years and the city has the right to again purchase by arbitration the exact value of all that is necessary for the operation of the system then existing.

"Meanwhile the city engineer with the approval of the council, has the authority to prescribe the character of the rails and materials used by the company and in all matters pertaining in paving and the use of the streets the city retains full control. The contract conditions are altogether favorable to the public while permitting a just return to the operators of the system."

The T-Rail Question.

As between T-rails, tram or center bearing head rails, and grooved girder rails, for use in street railways, there has been an active discussion of late, and the whole subject having been referred to a committee of the American Street Railway Association, it made its report to that body at the convention held at Atlanta in October. It may be remarked here, that this convention appears to have been a success, so far as most of the objects sought by it are concerned, but the time appears to have been too short for the full discussion of some subjects of interest and importance to the street railway industry.

The formulated question referred to the committee was, "Can the T-rail be satisfactorily used on paved streets?" In presenting its report the committee states that

the word "satisfactorily" has been considered "as applying to the point of view of the city and the driving public," as well as that of street railway companies, and the endeavor is made "to show that the T rail is not only satisfactorily used in streets, but that it is the best rail for the purpose." The report, prepared by Mr. Strathearn Hendrie, was printed in full in the *Street Railway Gazette* (Nov. 3), and probably no subject brought before the convention has a more important bearing upon the future of street railway traffic than this.

"The tendency of the larger cities in this country during the past 10 or 12 years has been toward smoother and better paved streets; and the general public, watching the progress of its city officials, has become in many places impatient of the action of the street railway people in maintaining the old forms of rail, which makes a ridge on the smooth surface of a first class modern street in an American city. Our travelers have come home from England and the continent extolling the grooved rail, and our city officials have in many cases forced either the English grooved rail or its American modification upon the railway companies. No street railway man hankers after the grooved head before he gets it, or enjoys it after he has put it in, and he therefore fights its introduction, demanding to be left alone, as he was, with his center-bearing or five-inch tram head. What we would show him—and through and beyond him his public—is that he can progress in the direction of their desires for a smooth street, and can give them something even more satisfactory to them than their favorite grooved rail."

On the other hand "questions of price, quick delivery, competition, coal-pile and construction, combine to recommend the T-rail" to street railway men. The tram-head has been proved not to be the cheapest rail in the end in these days of good street pavements and rapid transit. "Wagon traffic goes where it belongs—on the side of the street." The day of the old center bearing rail is regarded as past for most street railways and the choice now lies between the T-rail and the grooved headed rail.

"While the suggestion of a T-rail, for use in paved streets in cities, is startling to the average citizen, alderman or city engineer, and is in most cases impatiently rejected by them, yet we must recollect that the mention of a rail, such as steam roads use, calls up in their minds the idea of four or five inches of steel standing up above the street and of dilapidated plank crossings with half-drawn spikes, and we should go patiently to work to teach them that, as there is more than one way to supply motive power to a car, so there is more than one way of putting a rail in the street."

As an aid to the proper consideration of the subject in all its bearings, from the point of view which street railway men are compelled to take, as well as that of the public, the report contains a tabulated statement relating to 26 different railways where the T-rail is used. The general subject of street paving is considered. Over 50 different roads using T-rails and belonging to the association, either neglected or declined to respond to the inquiries of the committee, a fact which does not indicate that regard for mutual interest that ought to exist in such a body.

"The general consensus of opinion of the 26 roads referred to, and of the officials of the cities in which they run, is that if you can once get down 100 yards of T-rail and make a decent job of the paving, neither the officials nor the citizens will permit you to use anything else in the future. The main thing is to make your paving job a neat and good one. In three of the other cities, where there are at present no T-rails, but which are blessed with enlightened city officials, the T-rail is about to be made a requirement on the companies."

In the tabulated statement the replies are directed to the following points: Location; name of company; miles of rail of each variety in use, their weight and heights; construction; character of pavements and filling, and general remarks upon the estimation in which T-rails are held by both city and railway officials and the general public. Under these heads much valuable information has been collected.

Perfection of the Electric Railway Motor.

A STUDY of the history of the electric railway motor, says Lincoln Nissley in a paper recently read before the Pennsylvania Street Railway Association, and printed in the *Street Railway Journal* (October), shows that for the first few years after its introduction there was a strong tendency in the direction of complicated, fanciful and impracticable designs, outlandish forms of field magnets and unnecessary numbers of field cores and coils. The mechanical construction, too, has often been bad, the shaft being too small, the bearings weakly supported and the general workmanship inferior. Commutators and brushes have heretofore been the weakest spot in the railway motor, but the troubles with these have already been to a great extent overcome by the leading manufacturers. But serious difficulties still remain in connection with proper control and regulation. The government of motors as now effected by variable resistances in the circuit, necessarily involves great waste of power. This is unfortunate, but is it necessary? Mr. Nissley thinks not. The current, he suggests, should be adjusted by the motor itself, and not by the action of the motorman. The speed of the motor should remain absolutely constant, while for regulation between the motor and driving-wheels, the mechanical advantage should be made variable. The single-reduction motors of recent manufacture are a great advance in the onward march towards perfection. In the future will come better engineering, better construction, better mechanics, and the solution of the larger problems which will place the perfected railway motor on a better, cheaper and more successful basis.

Application of the "Booster" in Electric Railway Service.

DEVICES for raising the potential in certain branches of a system of electrical distribution without affecting that of other circuits supplied from the same source, have been in use for some years in connection with central station dynamos, and have come to be known by the expressive, if not elegant, title of "boosters." A paper read before the street-railway convention at Atlanta by J. H. Vail and H. S. Wynkoop, printed in the *Street Railway Gazette* (October 30), points out in a forcible manner some of the advantages which will accrue from the application of this device to the feeders of street-railway circuits. At present, the cost of copper for conductors seriously restricts the profitable extension of long distance lines for the accommodation of suburban traffic. For a given service, the cost of copper increases directly as the square of the distance from the generator, and this fact often renders the necessary investment in copper prohibitory when the line is to extend more than three or four miles from the power house. The authors state that accurate tests show that the commercial efficiency of the street-railway motor may be as high as 78 per cent. at normal voltage, but falls as low as 52 per cent. at two-thirds the normal. As a consequence, the cars when at a distance from the station, not only run at a much slower speed, but at an increased cost for power. The principle of the booster is that of overcoming the loss of voltage in transmission through long feeders by automatically raising the initial voltage of each feeder by an amount which shall exactly compensate for the drop of potential on the feeder at any given instant. The cross section of the feeder may therefore be calculated for ampere capacity only, the pressure being maintained at the service end of the line equal to that at the station end, irrespective of the length of the feeder or the amount of load. Several graphic diagrams are given which present the advantages of the proposed system in a very forcible manner. The most important general fact is, that the cost of copper when the device is used, increases only in direct ratio to the distance from the central station, instead of increasing as the square of the distance as under present conditions. This circumstance enables the street-car service to be extended to a distance of 10 to 20 miles from the power house, at the same time retaining the investment in copper within reasonable limits. One

great advantage of the booster is that it may be kept in the station and thrown at a moment's notice on any circuit which may be burdened with an abnormal load, thus greatly increasing the flexibility of the railway system as a whole. It would seem as if this simple device ought to save a great many tons of copper in such cities as Boston, Brooklyn and Philadelphia.

INDEX TO LEADING ARTICLES.

The journals quoted are indicated by initials, and their full titles are given in the opening pages of the Review. Other abbreviations are, Ill=Illustrated; W=Words.

*25763. The Street Railway Systems of St. Louis—Object Lessons in Efficient Service. Ill. William H. Bryan (E Mag-Dec.) 3500 w.

25848. Rapid Transit in New York (R G-Oct. 12.) 2400 w.

25956. Street Railway Repairs. J. B. Cahoon (E W-Oct. 20.) 5000 w.

†25971. Continued Discussion of Elmer A. Sperry's Paper—"The Electric Brake in Practice" (T A I E E-Oct.) 4000 w.

25987. A Few Figures on Electric Railway Expenses of Operation (E E N Y-Oct. 17.) 800 w.

25998. Rapid Transit Railways in European Cities. Ill. William Barclay Parsons (E N-Oct. 18.) 7500 w.

25999. An American Street Car of 1855. Ill. (E N-Oct. 18.) 800 w.

26000. Power-Brakes vs. Hand-Brakes for Street Cars. (Abstract.) E. J. Wessels (E N-Oct. 18.) 1500 w.

26002. Proposed New Rapid Transit Line in Chicago (E N-Oct. 18.) 1000 w.

26004 Progress in Gas Motors for Street Railways (Abstract.) Frank H. Mason (E N-Oct. 18.) 1000 w.

26005. Power Brakes for Street Railway Cars. Editorial (E N-Oct. 18.) 2100 w.

26006. A German Rail-Cleaning Machine for Street Railway Tracks. Ill. R. Ziffer (E N-Oct. 18.) 700 w.

26007. Mail, Express and Freight Service on Street Railways. (Abstract.) Richard McCulloch (E N-Oct. 18.) 2500 w.

26008. Brakeshoes for Street Railway Cars. (Abstract.) D. F. Henry (E N-Oct. 18.) 2000 w.

26011. City and Suburban Electric Railroads. (Extracts.) E. C. Foster (R G-Oct. 19.) 1800 w.

56013. Some Problems in the Construction and Operation of Elevated Railroads. A. A. Stuart (R G-Oct. 19.) 2700 w.

26016. Some Unsolved Problems of Elevated Railroads in Chicago. Editorial (R G-Oct. 19) 3500 w.

26018. The Electrical Expansion of the Chicago City Railway Company. Ill. Clement C. Smith (W E-Oct. 20.) 1600 w.

26019. Electricity in Elevated Railroads. B. J. Arnold (W E-Oct. 20.) 1600 w.

*26035. The Corrosion of Iron Pipes by the Action of Electric Railway Currents. Dugald C. Jackson, with Discussion (J A E S-Sept.) 9000 w.

26054. The Use of the Booster on Electric Railway Circuits. J. H. Vail and H. S. Wynkoop (S R G-Oct. 20.) 2000 w.

26055. Destructive Arcing of 500-Volt Fuses. W. S. Harrington (S R G-Oct. 20.) 1100 w.

26163. The T-Rail Track Construction of the Terre Haute Electric Railway. Russel B. Harrison (E W-Oct. 27.) 1700 w.

26185. The Elevated Railroads of Chicago. Ill. (R G-Oct. 26.) 4400 w.

†26269. Report of the Committee on "A Standard Form of Street Railway Accounts." H. I. Bettis (S R J-Nov.) 6000 w.

†26270. Report of the Committee on "Transfers on Street Railways." J. N. Beckley (S R J-Nov.) 2000 w.

†26271. Report of the Committee on "Can the T-Rail Be Satisfactorily Used on Paved Streets?" Strathearn Hendrie (S R J-Nov.) 1600 w.

†26272. Special Paper on "Brake Shoes." Powell Evans, with Discussion (S R J-Nov.) 8000 w.

†26273. The Poughkeepsie and Wappingers Falls Electric Railway. Ill. J. H. Vail (S R J-Nov.) 1500 w.

*26274. The Overhead Construction of the New Orleans Traction Company. Ill. B. Willard (S R R-Oct.) 800 w.

*26275. The Tamo and Toledo Electric Railway.—Two Small Iowa Towns United with a Paying Electric Road. Ill. (S R R-Oct.) 1200 w.

*26295. On Multiple Series Control of Motors on Small Electric Railways. John Langton (S R E N-Oct.) 1000 w.

26450. Uniformity in Stopping Cars in Philadelphia (S R G-Nov. 3.) 700 w.

26469. Rapid Transit for New York City and Municipal Ownership of Street Railways. Editorial (E R-Nov. 3.) 1200 w.

26599. Hewett's Conduit Railway Trolley. Ill. (W E-Nov. 10.) 1300 w.

26627. The New York Terminal Station of the Brooklyn Bridge. Ill. (E N-Nov. 8.) 4000 w.

Serials.

25022. The Working Expenses of Electric and Cable Railways (R W-Began Sept.—2 parts to date—30 cts. each).

25348. Mechanical Traction for Tramways (E E L-Began Sept. 14—3 parts to date—30 cts. each).

25954. Electric System of the Philadelphia Traction Company. Ill. Hermann S. Hering (E W-Began Oct. 20—Ended Nov. 10—4 parts—15 cts. each).

We supply copies of these articles. See introductory.

SCIENTIFIC MISCELLANY

Unsolved Problems of Science.

THE inaugural addresses of the presidents of the British Association for the advancement of Science and Art, have as a rule commanded the attention of the scientific world. Few of them, however, have been of a character to interest such as have not had special scientific training. The inaugural address of the Marquis of Salisbury, Chancellor of the University of Oxford, who has this year been elected to the presidency of the association, while in nowise lowering the literary standard of these addresses, deals with subjects of a kind comprehensible to educated people generally. As an address delivered by an eminent man before an old and honorable association upon a class of topics of profound interest to all thinking men, whether professional scientists or not, it is regarded as one of the most remarkable of recent public utterances. The *Popular Science Monthly* editorially speaks of it as an "allocution not to the British Association . . . . but to the British public." The problems named as unsolved, and yet which seem by their extreme interest and importance to challenge continued effort, notwithstanding all previous attempts have failed, indicate the purpose of the address almost as much as the way in which they were considered.

"In the presence of the high priests of science, I am only a layman, and all the skill of all the chemists the association contains cannot transmute a layman into any more precious kind of metal. Yet it is my hard destiny to have to address on scientific matters probably the most competent scientific audience in the world."

This from the opening paragraph of the address exemplifies the difficulty of adjusting the discourse to a level acceptable both to scientists of a high order and to educated men who in comparison are but laymen. Another sentence further illustrates the difficulty of the situation. "If a country gentleman, who was also a colonel of volunteers, were by any mental aberration on the part of the commander-in-chief to be appointed to review an army corps at Aldershot, all military men would doubtless feel a deep compassion for his inevitable fate. I bespeak some spark of that divine emotion when I am attempting to discharge under similar conditions a scarcely less hopeless task."

"Science with the university for many generations bore a signification different from that which belongs to it in this assembly. It represented the knowledge which alone in the middle ages was thought worthy of the name of science. It was the knowledge gained not by external observation, but by mere reflection. The student's microscope was turned inward upon the recesses of his own brain; and when the supply of facts and realities failed, as it very speedily did, the scientific imagination was not wanting to furnish to successive generations an interminable series of conflicting speculations. That science—science in our academical sense——had its day of rapid growth, of boundless aspiration, of enthusiastic votaries. It fascinated the rising intellect of the time, and it is said—people were not particular about figures in those days—that its attractions were at one time potent enough to gather round the university thirty thousand students, who for the sake of learning its teaching were willing to endure a life of the severest hardship. Such a state of feeling is now an archæological curiosity. The revolt against Aristotle is now some three centuries old. But the mental sciences which were supposed to rest upon his writings have retained some of their ascendency even till this day, and have only slowly and jealously admitted the rivalry of the growing sciences of observation.

"Few men are now influenced by the strange idea that questions of religious be-

lief depend on the issues of physical research. Few men, whatever their creed, would now seek their geology in their books of their religion, or on the other hand, would fancy that the laboratory or the microscope could help them to penetrate the mysteries which hang over the nature and the destiny of the soul of man."

Three of the yet unsolved problems of science form the subject of the address; to wit, the nature and origin of what are called chemical elements; the ether which is described as "a half-discovered entity," and animal and vegetable life styled "the action of an unknown force upon ordinary matter." The mystery of the material elements, is regarded most notable, on account of the disappointed hopes that have been reared upon discoveries of new means of research made from time to time. Among these was the method of spectrum analysis.

"Men thought that with an instrument of such inconceivable delicacy we should at last find out something as to the nature of the atom. The result has been wholly disappointing. Spectrum analysis in the hands of Dr. Huggins and Mr. Lockyer and others has taught us things of which the world little expected to be told. We have been enabled to measure the speed with which clouds of blazing hydrogen course across the surface of the sun; we have learned the pace—the fabulous pace—at which the most familiar stars have been for ages approaching to or receding from our planet, without apparently affecting the proportions of the patterns which, as far as historical record goes back, they have always delineated on the evening sky. We have received some information about the elementary atoms themselves. We have learned that each sort of atom, when heated, strikes upon the ether a vibration, or set of vibrations, whose rate is all its own; and that no one atom or combination of atoms, in producing its own spectrum, encroaches even to the extent of a single line upon the spectrum that is peculiar to its neighbor. We have learned that the elements which exist in the stars, and especially in the sun, are mainly those with which we are familiar upon earth. There are a few lines in excess to which we can give no terrestrial name, and some still more puzzling gaps in our list. It is a great aggravation of the mystery which besets the question of the elements that, among the lines which are absent from the spectrum of the sun, those of nitrogen and oxygen stand first. Oxygen constitutes the largest portion of the solid and liquid substance of our planet, so far as we know it; and nitrogen is very far the predominant constituent of our atmosphere. If the earth is a detached bit whirled off the mass of the sun, as cosmogonists love to tell us, how comes it that in leaving the sun we cleaned him out so completely of his nitrogen and oxygen that not a trace of these gases remain behind to be discovered even by the sensitive vision of the spectroscope?

"All these things the discovery of the spectrum anslysis has added to our knowledge; but it has left us ignorant as ever as to the nature of the capricious differences which separate the atoms from each other, or the cause to which those differences are due."

Dalton's, Kirchoff's, and Mendeleef's researches have not, so far as can now be seen, helped toward a solution. "What the atom of each element is, whether it is a movement, or a thing, or a vortex, or a point having inertia, whether there is any limit to its divisibility, and, if so, how that limit is imposed, whether the long list of elements, is final, or whether any of them have any common origin, all these questions remain surrounded by a darkness as profound as ever. The dream which lured the alchemists to their tedious labors, and which may be said to have called chemistry into being, has assuredly not been realized, but it has not yet been refuted."

Of ether it is asserted that "it would be a great exaggeration of our knowledge" to "speak of it as a body, or even a substance . . . When nearly a century ago, Young and Fresnel discovered that the motions of an incandescent particle were conveyed to our eyes by undulation, it followed that between our eyes and the particle there must be something to undulate.

In order to furnish that something, the motion of the ether was conceived, and for more than two generations the main, if not the only, function of the word ether has been to furnish a nominative case to the verb to undulate." Notwithstanding Professor Maxwell's discovery of the coincidence existing between "the figure that expresses the velocity of light" and "the multiplier required to change the measure of static or passive electricity into that of dynamic or active electricity," the "attractive experiments of Professor Hertz," etc., "the mystery of the ether, though it has been made more fascinating by these discoveries, remains even more inscrutable than before."

Life,—"the mysterious influence which is able to strike across the ordinary laws of matter and twist them for a moment from their path,"—what is it? "Biology has been exceptionally active and successful during the last half century. Its triumphs have been brilliant and they have been rich enough not only in immediate results but in the promise of future advance. Yet they give at present no hope of solving the great central mystery. The doctrine of evolution does not help. If however the doctrine of natural selection be rejected, we have no resource but to fall back on the mediate or immediate agency of the principle of design."

In concluding the address an expression of Lord Kelvin is quoted with approval:

"I have always felt that the hypothesis of natural selection does not contain the true theory of evolution, if evolution there has been in biology."

Instruction in Physics and Thermodynamics.

THE science of thermodynamics in which the late Professor Rankin was among the famous pioneers, is now scarcely fifty years old, yet it has taken rank in importance with the older sciences, and is taught in all technical schools worthy of the name. To it are due nearly all the refinements in steam engineering which have made the last half of the nineteenth century a distinct epoch in the history of the steam engine. Without it the caloric engines of Ericsson and others could scarcely have come into existence, and the gas engine (progress in which during the last twenty years has been one of the remarkable features of this period), if it had ever come into use at all, would have been only a crude, inefficient machine with limited application, scarcely worthy to rank as a motor for industrial purposes.

Such having been the practical results of this science, it is interesting to read what is said in *Nature* (October 4) about the facilities afforded for its study, and the course of instruction pursued in it at one of the great technical schools. Under the title "Physics and Engineering at the McGill University, Montreal," is given an illustrated description of the thermodynamic, geodetic, electrical and mathematical laboratories, at this celebrated institution of learning, with illustrations and descriptions, and also of its famous testing laboratory, and its well-equipped machine shop, which have contributed to make it a typical modern technical school.

"The McDonald Engineering Building, erected and equipped through the munificence of Mr. W. C. McDonald, one of the governors of the university, is a fine structure containing laboratories for all branches of engineering work. The Physics Building owes its existence to the generosity of the same donor. It has been designed for the teaching and study of physics (including mechanics) with special regard to (1) its intrinsic importance as an integral part of a liberal education in the Faculty of Arts; (2) its essential necessity as a study preliminary to the courses of engineering, mining, and practical chemistry in the Faculty of Applied Science, and (3) the prosecution of scientific research." The completeness and liberality with which all the necessary plant has been put into these buildings has hitherto never been equaled. "It will astonish the various authorities who have similar technical institutes under their control in this country (England) to know that the cost of this equipment alone of the two buildings came to very nearly one hundred thousand pounds sterling! Compare this princely generosity with the fact that only twenty-

three thousand pounds were asked for to erect and equip the engineering laboratory of the University of Cambridge. The exact amount of Mr. McDonald's benefactions has not been told, but they are certainly nearer seven than six figures. Everything in fact required in the pursuit of physical and engineering study has been lavishly provided. Few occupiers of chairs of physics here are in the fortunate position of Professor Cox. He was instructed to spare no expense in obtaining everything required to carry on work in experimental physics. 'From first to last,' he says, 'whether it was a question of part of the buildings or of the equipment, I have heard no other language from Mr. McDonald than 'Let us have everything of the best, with a definite aim for everything, but always of the best.'"

The equipment of the thermodynamic laboratory and the course of study pursued in this science are notable. In this laboratory the feature of most interest is a four-cylinder steam engine arranged double tandem fashion designed by Messrs. Schonheyder and Druitt Halpin, London, under the general direction of Prof. Carus-Wilson of McGill College, and built by Yates and Thom, Blackburn. This engine is described as "a double tandem inverted direct acting quadruple expansion engine," to work at 200 pounds pressure on the gage, developing eighty horsepower at about 150 revolutions, and it may be used in a large number of different ways, for the elucidation of the thermodynamic principles involved in the theory and practice of steam engineering. "It may be run either quadruple, triple, double, or single expansion. And as the pipes are led both to condenser and atmosphere, all of these types may be tried either condensing or non-condensing." The power delivered is accurately measured by hydraulic brakes designed by the late R. E. Froude, and improved by Prof. Osborne Reynolds. "In fact, a complete balance sheet of the heat supplied, used, and rejected by the engines can be made, and the materials for the study of Hirn's analysis are easily obtained."

A special laboratory is provided for the third year course in thermodynamics. This contains apparatus for the experimental study of the so-called permanent gases, which as has been now amply demonstrated are such only under special conditions of temperature and pressure. In this laboratory are all the most approved instruments and appliances for measurement of temperature and pressure. The third and fourth year courses of study in thermodynamics are as follows:

The third year laboratory contains apparatus for the demonstration of the properties of the permanent gases and of steam: and a complete set of the most modern types of pyrometers and thermometers, and gages, mercury columns, planimeters, and calorimeters, render possible investigation of many problems of importance to the engineering world.

"In the third year, students of thermodynamics are taught the principles of the science by direct experiment; and original research is encouraged during the summer under the direction of the professor.

"In the fourth year, engine boiler and fuel testing is largely worked at; and the higher parts of the subject are explained by reference to the results obtained from the indicator card, as measured and examined for moisture and heat exchange. The gas and hot-air engines are tested again and again, and the effect of the different factors which modify results pointed out by careful observation."

Education of Engineers.

IN an essay on Engineering Practice and Education in the *Journal of the Franklin Institute* by Prof. Gaetano Lanza, the importance of thorough school drill in scientific principles is emphasized, and the two fundamental sciences upon which principles involved in the practice of engineering rest are held to be mathematics and physics. While natural laws can only be discovered by experiment, the function of mathematics is to draw necessary conclusions from assumed data. If the data are not correct the necessary conclusions may be false, though no fault in mathematical reasoning may exist. It is the function of physics in the practice of the

arts to supply needed fundamental data, and to correct false assumptions.

An engineer in order to be fit "to assume responsibility at some portion of his career, before he allows himself to use a formula in practice ought to know just how it is deduced. The rule-of-thumb engineer ignores this matter, and allows himself to risk the money, the safety and the lives of his fellow-men by making use of constants and mathematical formula found in some hand-book or elsewhere; using these constants and formulæ blindly, without knowing how they were deduced, or whether they have any reasonable foundation to stand on; or, in other cases, contents himself with merely guessing at what should be the dimensions of the various parts of a structure or machine. The natural result of such a course is poor work, and often disaster; and the world is rapidly waking up to this fact, so that important engineering work is being less and less entrusted to these rule-of-thumb engineers."

Neither drill on puzzling problems, nor long practice in "a certain round of operations" will qualify a man to use mathematical methods with skill in his profession, unless these modes of study are directed by a competent teacher.

The Rubber Traders of the Ucayali Valley.

AN illustrated article with a map of the Ucayali Valley in Peru, by José de la Sanchez in the *India Rubber World* (Oct. 15) gives a description of a region little known to the average citizen of the United States, yet one from which much of a material necessary to personal comfort and to the conduct of important industries (india rubber) is derived. The impression that much of the interior of Peru is difficultly accessible, usually gained from ordinary maps of Peru, is corrected. "Intrepid explorers have established the fact that the water-courses there, so carelessly depicted on the school-maps, form an extensive system of navigable streams discharging through the Amazon into the Atlantic ocean, and thence coming in touch with the great transportation systems of the world. The further fact having been established of the prevalence along these streams of rubber-bearing trees of the genus Hevea —the product of which is the most valuable freight in the world, barring the precious metals,—it has remained only for men of enterprise and capital to locate in this field and avail themselves of nature's great opportunities. The fact is that many individuals of this class are already engaged in rubber-gathering in Peru, and that marked success has attended the efforts of some, although their distance from any great trade center may have kept the world in ignorance of their existence."

Steamship lines exist whereby freights "may be billed from New York, or the great European seaports to Iquitos, far up on the Amazon, and exports from that far-away port are dispatched regularly for North America and the transatlantic markets." But when at Iquitos the head of navigation is by no means attained. A little further up is the great Ucayali river which contributes its waters to the vast tide of the Amazon, and this tributary, as well as steams flowing into it are navigable, the lands through which they flow producing valuable commodities among which rubber output is at present most notable, and likely to continue so for some time. The rubber product of these upper tributaries whose sources are in a region in the vicinity of Cuzco, does not, however, at present reach the markets of the world through the Amazon, but is conveyed to the Pacific by means of country roads and railroads, trains now being run as far toward Cuzco as Sicuani. Some "German merchants have extended their enterprise to the banks of the river Paucartambo, the waters of which, finally reach the Ucayali."

As yet Iquitos is the highest Amazonian point to which shipments can be made directly from New York, but the large and productive region "Amazonian Peru," must at some time be brought into closer connection with United States commerce. Flour and kerosene are the principal commodities now shipped from New York to eastern Peru. Ubiquitous England has the monopoly of the trade in finer manufactured goods.

INDEX TO LEADING ARTICLES.

The journals quoted are indicated by initials, and their full titles are given in the opening pages of the Review. Other abbreviations are, Ill=Illustrated; W=Words.

*24443. Presidential Address of the Marquis of Salisbury Before the British Association (E E L-Aug 10.) 6600 w.

*25761. The Armor Plate Question—1894. Ill. W. H. Jaques (E Mag-Dec.) 3500 w.

*25769. Restoration of the Antillean Continent. (Abstract.) J. W. Spencer (G M-Oct.) 1500 w.

*25770. On a Series of Saurian Footprints from the Cheshire Trias (with a Note on Cheirotherium). Osmund W. Jeffs (G M-Oct.) 2000 w.

*25771. The Aptychus. Ill. Ernest H. L. Schwarz (G M-Oct.) 1800 w.

*25787. The Ideal Preparatory School for Engineering Students. William Kent, in Cassier's Magazine (S L-Oct.) 1800 w.

25802. Cathodic Rays. Ill. C. E. Guillaume (Sc A S-Oct. 13.) 3000 w.

25803. New Researches on the Infra-Red Region of the Solar Spectrum. Professor Langley (Sc A S-Oct. 13.) 1200 w.

*25822. The Uses of Thermodynamics. Editorial (I & I-Sept. 28.) 900 w.

*25865. Uses of the Tailless Kite for Meteorological and Similar Purposes (Inv-Oct. 6.) 1300 w.

25867. Professor Dewar's Investigations (P A-Oct. 15.) 1600 w.

*25881. British Forestry (J S A-Oct. 5.) 2400 w.

25888.—$1. The American Cave-Dwellers: The Tarahumaris of the Sierra Madre. Carl Lumholtz (B G S-Sept. 30.) 8400 w.

25889.—$1. Fur Seals and the Behring Sea Arbitration. J. Stanley Brown (B G S-Sept. 30.) 13600 w.

25890. The Laboratory and Machinery.—Technical and Mechanical Matters of Value to Practical Man (T-Oct. 15.) 1600 w.

*25909. Physics and Engineering at the McGill University, Montreal. Ill. (N-Oct. 4.) 3000 w.

*25929. Dust Explosions in Briquette Works (C G-Oct. 5.) 1000 w.

*25934. Artillery Fire in the Chinese War. Editorial (Eng L-Oct. 5.) 1700 w.

25941. Sins of the Pay Roll. Fred Woodrow (A S-Oct. 13.) 800 w.

†25958. A History of Seamless Cotton Hose. Cornelius Callahan (I R W-Oct. 15.) 1500 w.

†25959. The Rubber Traders of the Ucayali Valley. Ill. José de la Sanchez (I R W-Oct. 15.) 1500 w.

†25960. The Rubber Product of British India (I R W-Oct. 15.) 1100 w.

†25961. Cholera and the Sultan. Ernest Hart (N C-Oct.) 7000 w.

*25975. The Influence of the Early Renaissance on Painting. Ill. Banister F. Fletcher (A R-Oct.-Dec.) 7000 w.

25990. Specifications for a Proposed Catamaran Air Ship for United States Coast Defense. Ill. Invented by J. Franklin Cameron (Sc A S-Oct. 20.) 1400 w.

25993. The Paris Observatory.—The Oldest and Newest Telescopes. Ill. (Sc A S-Oct. 20.) 1000 w.

26020. How and Where Paranite Insulation is Made. Ill. (The Factory of the Indiana Rubber and Insulated Wire Company.) (W E-Oct. 20.) 2000 w.

26030. Egypt as a Cotton-Grower (M R-Oct. 19.) 2700 w.

†26038. Sanitary Delusions. F. L. Oswald (N S R-Oct.) 2200 w.

†26039. What is Science? Compiled by Mrs. H. O. Ward (N S R-Oct.) 5000 w.

†26040. The Influence of Heat and Cold upon Microbes. Lawrence Irwell (N S R-Oct.) 2800 w.

*26051. Engineering as a Learned Profession. Editorial (E-Oct. 12.) 3000 w.

*26092. Fifteen-Inch Pneumatic Dynamite Gun. Ill. (I & I-Oct. 12.) 3800 w.

*26134. Measurements of Precision. T. C. Mendenhall (N-Oct. 11.) 5000 w.

*26151. Modern Agriculture in France. H. Blerzy (Ch-Nov.) 4000 w.

*26152. The Value of Geological Science to Men. N. S. Shaler (Ch-Nov.) 3000 w.

†26153. The Glaciers of Greenland. Ill. Angelo Heilprin (P S M-Nov.) 4000 w.

*26212. The Field Columbian Museum. Editorial (E-Oct. 19.) 1600 w.

26261.—$1. Some Notes on Fire Protection Engineering. Ill. John R. Freeman (A E C U-1894.) 14500 w.

†26262. The Fight Off the Yalu River. Ill. Hilary A. Herbert (N A R-Nov.) 4400 w.

*26267. On Hollow Pyramidal Ice Crystals. Ill. (Abstract.) Karl Grossmann and Joseph Lomas (N-Oct. 18.) 1500 w.

*26284. The Model Foreman Engineer. Joseph Newton (I C B-Oct. 19.) 1500 w.

*26317. The Salt Trade of the Soudan (B T J-Oct.) 900 w.

*26319. New Brazilian Customs Regulations for Porto Alegre and Rio Grande do Sul (B T J-Oct.) 2500 w.

*26320. New United States Customs Tariff (B T J-Oct.) 6000 w.

*26321. Tariff Changes and Customs Regulations.—Russia, Sweden, Switzerland, France, Spain, Portugal, Porto Rico, Guatemala, China, Peru, British India, etc. (B T J-Oct.) 3500 w.

†26331. Tests of Automatic Fire Sprinkler Heads. Ill. D. S. Jacobus (S M-July.) 4500 w.

†26332. Comparison of Insulating Materials for Cold Storage. Rudolph Riege and Frank L. Parker (S In-July.) 2000 w.

We supply copies of these articles. See introductory.

26345. Unwelcome Discoveries.—From the Minneapolis Times (Sc A-Nov. 3.) 600 w.

26353. The Progress of Astronomical Photography. (Abstract.) H. C. Russell (Sc A S-Nov. 3.) 3500 w.

26354. About the "Freezing Up" of Compressed Air. Frank Richards (A M-Nov. 1.) 2400 w.

†26376. On Variations and Mutations. W. B. Scott (A J S-Nov.) 8000 w.

†26378. On the Origin of Bitumens.—A Retrospect. S. F. Peckham (A J S-Nov.) 2500 w.

†26380. A Study of the Cherts of Missouri. Edmund Otis Hovey (A J S-Nov.) 2500 w.

†26381. On Copper Crystals in Aventurine Glass. Henry S. Washington (A J S-Nov.) 2500 w.

26399. The Pneumatic Dynamite Gun on the Brazilian Cruiser "Nictheroy." Edward Brimley (E N-Nov. 1.) 1500 w.

*26434. Theoretical and Experimental Investigations on the Visual Sensations and on Photometry. Ill. André Broca (El-Oct. 26.) 2000 w.

*26443. Engineers of To-day—and Yesterday. G. H. Hill. Ill. (E Rev-Oct. 20.) 800 w.

*26446. The Engineering Industries of Manchester. Ill. (E Rev-Oct. 20.) 24500 w.

*26449. Modelling in Clay (I C B-Oct. 26.) 1500 w.

26457. The Photometry of Diffused Reflection. E. Lommel (A G L J-Nov. 5.) 1200 w.

26484. Heat. F. R. Law (Pr-Nov.) 10000 w.

26519. A New Classification of Economic Geological Deposits. R. W. Raymond (E M J-Nov. 3.) 2500 w.

26530. Antoine Louis Baryl and His Monument. Ill. (Ml N-Nov.) 1400 w.

26535. On the Velocity of Cathode Rays. J. J. Thomson (E N Y-Nov. 7.) 2700 w.

*26544. On Modern Developments of Harvey's Work. T. Lauder Brunton (N-Oct. 25.) 10200 w.

26578. Pompeii (A A-Nov. 10.) 2000 w.

26588. Church Bells. S. S. Stanley (A & B-Nov. 10.) 2000 w.

†26601. The Limit of Post-glacial Submergence in the Highlands East of Georgian Bay. F. B. Taylor (A G-Nov.) 6500 w.

†26602. A Review of the History of the Great Lakes. J. W. Spencer (A G-Nov.) 4200 w.

†26603. Drainage Systems of the Carboniferous Area of Michigan. E. H. Mudge (A G-Nov.) 2400 w.

†26604. The Mineralogical Characters of Certain New Jersey Limestones. Lewis G. Westgate (A G-Nov.) 1500 w.

†26605. The Ventral Armor of Dinichthys. Ill. Albert A. Wright (A G-Nov.) 1800 w.

26606. Herman Ludwig Ferdinand von Helmholtz. Ill. (Sc A-Nov. 10.) 1100 w.

26609. Engineering Facts. George Y. Wisner (Sc A S-Nov. 10.) 1800 w.

26611. Fuels in the United States (M S P-Nov. 3.) 600 w.

26628. Co-operation Among Engineering Societies. Editorial (E N-Nov. 8.) 1500 w.

†26637. Bolivia as a Source of Rubber Supply. William Nelson Black (I R W-Nov. 10.) 800 w.

†26638. The Cable Process for Treating Compounded Rubber (I R W-Nov. 10.) 900 w.

†26639. The Rubber Production of West Africa (I R W-Nov. 10.) 1800 w.

†26640. The Growing Use of Rubber for Tires (I R W-Nov. 10.) 800 w.

†26641. Glimpses of the Bolivian Rubber Country. M. F. Sesselberg (I R W-Nov. 10.) 1400 w.

*26647. The "Black Ivory" Trade (F'y-Oct. 12.) 1800 w.

*26648. Petroleum—The Light of the World (F'y-Oct. 12.) 1400 w.

Serials.

21763. Engineering Practice and Education. Gaetano Lanza (J F I-Began May—7 parts to date—45 cts. each).

23443. Sculptured Monuments of Boston. Ill. Frank T. Robinson (Ml N-Began July—5 parts to date—15 cts. each).

24240. On Some Life Zones in the Lower Palæozoic Rocks of the British Areas, as Defined Mainly by Researches during the Past Thirty Years. Henry Hicks (G M-Began Aug.—3 parts to date—30 cts. each).

24462. Graphic Statics. Ill. W. W. F. Pullen (P Eng-Began Aug. 10—7 parts to date—30 cts. each).

24997. On a Collection of Jurassic Cephalopoda from Western Australia. Ill. G. C. Crick (Began Sept.—2 parts to date—30 cts. each).

25280. Wood Pulp, and Its Conversion into Paper and Other Products (I & I-Began Sept. 7—Ended Oct. 12—6 parts—30 cts. each).

25313. The Manufacture of Briquette Fuel. William Colquhoun (I C T-Began Sept. 14—Ended Oct. 5—4 parts—30 cts. each).

25654. Aërial Navigation. A. F. Zahn (J F I-Began Oct.—Ended Nov.—2 parts—45 cts. each).

25664. Letters to Young Engineers. E. G. J. McCudden (J E—Began Sept. 1—3 parts to date—45 cts. each).

25885. Engineering Lectures. Walter M. McFarland (Eng-Began Oct. 13—3 parts to date—15 cts. each).

26049. An Andean Oasis (E-Began Oct. 12—Ended Oct. 19—2 parts—30 cts. each).

26050. Some Remarks on Modern Naval Tactics (E-Began Oct. 12—3 parts to date—30 cts. each).

26560. Indiana Industries (Ir Age-Began Nov. 8—1 part to date—15 cts).

COMMENT & CRITICISM

Wealth from Legislation.

MR. WM. NELSON BLACK in his recent timely paper "The Prevailing Jealousy of Wealth" states so many timely truths, that added emphasis may be more useful than criticism; but he makes one omission that you may find space to correct. He considers the distribution of wealth during the past forty years, but does not mention the increase of legislative activity and interference; and whether, as would be natural, aggregated capital has not been able to use these added powers for its own particular advantage. If it has, he would find one just motive for the "Jealousy of Wealth" among the many unjust ones that he so rightly condemns.

It is no answer to say that much of this legislation has been procured by other forces than wealth. Its effect is what we must consider.

The question is whether in the Government of to-day the last million of the multi-millionaire (controller or owner) does not have more weight than the single million in other hands. Industrially it should have; but certainly not in the making and administering of statutes. Instances are numerous, but who questions that the weight of aggregated and ready capital has been increased by the Interstate Commerce law, the Illinois elevator statutes and decisions, and the repeated changes in the import tariff.

Mr. Black rightly distinguishes between the *creation* and *accumulation* of wealth, but his examples are not all fortunate. Mr. Gould undoubtedly *created* more millions than he left; but among the millions he "produced," Mr. Black has overlooked the millions he *created* with a printing press in Erie, and the other millions he *accumulated* by consolidation in various railways.

It appears to me that the unreasoning and unjust feeling toward wealth is founded on the unformulated distinction by the masses of the ethical difference between creation and accumulation.

G. C. HEWETT.

Washington, D. C.

A Technico Legal Puzzle.

I NOTE the remarks in the Department of Electricity (October number) with reference to the destruction of gas and water pipes, cable covers, etc., by the return currents of the trolley roads.

This has been an "open secret," for a long time, among electrical people; but you have spoken and the matter is now public.

The Bell Telephone Company have tried to keep the destructive action away from its cables, by fastening large lead sheets to water and gas pipes and cable covers, that the current might "spread itself," dissolving or corroding the sheet of lead instead of the pipe or sheath. This effort failed utterly; for the sheet of lead was soon honeycombed and destroyed.

Welding the rails to make a good return conductor promises better results, but an open joint must be left at frequent intervals for expansion and contraction. This joint must be bridged, and there you are again, with a defective joint as soon as the weather has had time to act upon it.

You speak of court decisions. Although the telephone companies were on the highways first, this circumstance has not protected them against trolley induction troubles and they have been forced to adopt metallic circuits. Worse than this, in Milwaukee and other cities telephone and telegraph poles and wires had been ordered from the streets as *unsightly obstructions*. Yet, almost in the same breath, permission was given to the electric railway companies to erect their tangle of feed wires, guys, stays, switches and trolley-wires, with at least four times as many

poles to each block as were required for the transmission of intelligence.

So long as the destruction of underground property was confined to the cables of telegraph and telephone companies, and the gas companies' pipes, the thrifty citizen looked on with indifference, like Artemus Ward during the rebellion, who was willing to sacrifice all his wife's relations on the altar of his country. But now that the city engineers have discovered that his water pipes are being honeycombed and must be renewed, the taxpayer proposes to have his say; and his voice will be multitudinous and vociferous.

Wouldn't it be funny, if the electric railways in cities were finally forced to fall back upon the poor, despised double trolley?

C. H. HASKINS.

New York, 1894.

Theater Building in American Cities.

THE clipping from the "Current Topics" columns of "Electricity" which you were kind enough to send me contains nothing which should modify in any manner the paragraph from my article of "Theater Building in American Cities" quoted and attacked by the author of "Current Topics."

Of course I admit that the substitution of electric lighting for gas removes certain elements of danger, and particularly those enumerated in "Current Topics."

But I do not ignore the imminent danger to dry wood structures from contact with, or close vicinity to overheated electric light wires, which has been the cause of innumerable fires, information and comment about which can be found in the columns of every journal devoted to the interests of the fire underwriters.

If the electrician is disposed to maintain that in a well designed and well constructed system of electric conductors such overheating will not occur, let him remember that the person who will erect a theater of cheap and therefore combustible structural materials will also provide a cheap and therefore probably unsafe system of wiring. But even when it is intended to provide a high grade electric installation, there exists the possibility of an occasional imperfection of material or workmanship or both, which with the cussedness of inanimate things is sure to occur when its existence involves the greatest danger. I therefore still maintain that notwithstanding the introduction of electric lighting "there is as much reason as ever why theaters should be built entirely of incombustible material."

DANKMAR ADLER.

Chicago, 1894.

The True Cause of the Lack of Progress in South America.

I WAS much interested in the letter entitled "The Obstacle in Peru" which appeared in a recent number of your Magazine over the signature "N. J. S."

Although I have not visited Peru, I endorse what that gentleman says, as it tallies so exactly with my own experience in another of the South American states, where the conditions appear to be very similar. I have lately returned from the Republic of Colombia, where I spent three years in the service of an English gold mining company. Whilst in that country, I noticed precisely the same state of affairs, and suffered under just those disabilities to which your correspondent referred. Colombia which owes, exclusive of many years' arrears of interest, nearly two million pounds sterling (£2,000,000), chiefly to England, I believe I am correct in saying, yet finds money to pay to the Pope a yearly subsidy of two hundred thousand dollars gold ($200,000) and this with the rate of exchange on the paper currency varying from 150 to 200 per cent. I know, indeed, as a positive fact, ascertained during a recent stay in New York, that the Colombian government has not yet paid the gentleman (an American) who represented them at the late "World's Fair," the remuneration agreed upon for his services. After leaving Colombia, I made a short tour through Mexico where, as is well known, the state has for a considerable number of years been officially dissociated from the church. To any one who happens to be acquainted with both Colombia and Mexico, the enormous superiority of the latter country

in material prosperity and advancement, cannot fail to be apparent. Colombia is, in short, practically run by a handful of Jesuits in Bogota, the capital. I feel sure any impartial American or English observer, who knows the country, will fully bear me out in this statement. In fact, those of the consular agents of both countries with whom I am acquainted, have admitted as much to me as the result of their experience of Colombia. I should like to add that I am not in the least actuated by any motives of religious animosity. Possibly some Colombian may write, refuting my assertions, but—"'Tis true, 'tis pity, and pity 'tis, 'tis true." F. O.

London, Eng., 1894.

American Portland Cement.

IN your review of the industrial press for November I note that you make some comments on Mr. Tucker's paper on cements as published in the August *Brickbuilder*, which ends with an unjust criticism on American Portland Cements. The validity of Mr. Tucker's views was attacked in the September and October numbers of the *Brickbuilder* by Prof. Newbury and myself.

That this article was unjust to American Portland Cement can be seen by Mr. Tucker's reply to the writer in the October *Brickbuilder* where he acknowledges that some American Portland cements are (to use his own language) "equal, nay, superior, to the foreign cement," but this is only done after bringing to his attention places where American Portand cement factories have supplied their product for work in which the best foreign cement on the market failed to pass the specifications; and then he insinuates that this cement, served to these particular operations, was especially prepared and different from what the American manufacturer usually places on the market. This, the writer, as a representative of the oldest brand of American Portland cement and the brand used in the operations referred to, wishes to emphatically deny. This brand of cement is the same to-day, anywhere it is found, and is always the best that can be produced in any country.

I am well aware that there are many engineers who have the same opinion as Mr. Tucker about American cement and that is the reason the writer takes this matter up. There are about twenty-five importers of foreign cement to one manufacturer of American cement, and it is the business of these importers to try to discredit the quality of American Portland cement. Some do it honestly. Having been told by a manufacturer in Europe that his cement was "the best in the world," they naturally conclude that it must be better than the American cements, and not wishing to be better informed, they remain uninformed till they meet some engineer who, not satisfied with what has been told him by importers, makes a long and careful series of tests, with both American and foreign cements, the results of which show that many of the Belgian and English Portlands are of a lower quality than any American brand, and that the bulk of the American brands are equal to the very best of the German, French or Danish.

Unfortunately for the American Portland cement industry, very few engineers in the past have had the time or the facilities to carry out such tests, but the uses to which Portland cements are now put, are such that a careful engineer must make tests and find out exactly what he is using.

If Mr. Tucker made any tests that would warrant a man to make the assertions he has made about American Portland cement, or to substantiate his insinuation that the German cements are of a more uniform quality than the American cements, the writer would like to see them published at some early date. He gave no data in the article appearing in the *Brickbuilder*.

WM. G. HARTRAUFT.

Philadelphia, Pa., Nov. 13, 1894.

NEW BOOKS of MONTH

ELECTRIC LIGHTING PLANTS; THEIR COST AND OPERATION. Data Compiled from Station Reports of Electric Lighting Plants Employing Overhead Circuits, With Suggestions Pertaining to the Information Usually desired by the Non-Technical Purchaser. By W. J. Buckley. Sold by Ft. Wayne Electric Corporation. [Paper. 12mo, 275 p., with diagrams and folding plans. $2.]

"NOW what I want is Facts... Facts alone are wanted in life. Plant nothing else and root out everything else. You can only form the minds of reasoning animals upon Facts; nothing else will ever be of any service to them. . . .Stick to Facts, sir!" If the above quoted observations of Thomas Gradgrind ever had a more pat application to any condition of affairs than it has at the present day to the electric-lighting business, it would surely be a matter of difficulty to point it out. We have had more than enough works on the subject of electric lighting; the electrician's book-shelves fairly groan under them, but when the intending purchaser of an electric-light plant seeks in them for Facts, he is liable to meet with disappointment. But in this work of Mr. Buckley's he will find most of the Facts he has hitherto sought in vain, and bottom-facts at that. The subject-matter is confined to arc and alternating incandescent plants of comparatively moderate size; the maximum in the former case being a 2000 candle-power, and in the latter a 3000 light plant. It is difficult to imagine any possible question relating to the cost of construction, maintenance or operation of this class of electric plants, which is not clearly and completely answered in this work. The prices are given in all cases; not "list" prices, but net prices; the actual prices of to-day, and not of last year or the year before. This is a subject on which the author is evidently at home, inasmuch as he informs us in his preface that he has been in active service as a salesman for a well-known electrical manufacturing corporation for nearly ten years. It would take too much space to attempt to enumerate the contents of the book; it is enough to say that it is full to repletion with information of the utmost value to central-station managers as well as purchasers and owners, most of which is not to be found elsewhere in print. Numerous tables, charts and diagrams accompany the text, and there is also an especially valuable series of plans of American central-stations actually in operation, accompanied with brief criticisms pointing out their several excellencies and defects. In the appendix are the rules of the Chicago Underwriters' Association; the National Electric Light Association; Mr. Ayer's excellent instructions to employés, and other useful matters of like nature.

CENTRAL STATION BOOKKEEPING AND SUGGESTED FORMS. With an Appendix for Street Railways. By Horatio A. Foster, Mem. A. I. E. E. New York: The W. J. Johnston Co., Ltd., 253 Broadway. [Cloth. 139 pages, 76 forms and diagrams. Price $2.50.]

UNTIL data relative to itemized cost of the electric distribution are collected, it will be difficult to judge how little most station managers know about details. Most of the large low tension stations keep records of accurate data, but high tension stations, both arc and alternating incandescent, seldom do this. By small stations all such records are neglected.

The importance of such records of operation and cost can scarcely be exaggerated. No central station manager is well prepared to do business in times of close competition with gas and other companies, until he knows the itemized cost of supplying the electric current. To enable him to reach this desirable information with minimum labor this work has been written, and the well-known name of the author gives assurance that the work may be consulted with confidence.

The book contains diagrams for the organization of the staff of electrical central stations, and a classification of ac-

counts and reports, including sample forms for every department. As the name indicates, the work is devoted mainly to the accounting department, both of central stations and street railways, and outlines a complete scheme for its organization and routine which will enable the management to determine at any moment the condition of business, and particularly the unit cost of the generation and distribution of current. In an appendix is furnished a classification of accounts of electric street railways, together with instructions, forms of books, etc., necessary to carry it out.

NOTES ON THE VENTILATION AND WARMING OF HOUSES, Churches, Schools and Other Buildings. By the late Ernest H. Jacob, M. A., M. D., Professor of Pathology in Yorkshire College, Leeds. New York: E. & J. B. Young & Co. [Cloth, 16mo, 124 p. Illustrated. 25 cents.]

THIS volume forms one of the series of manuals of health originally issued by the Society for Promoting Christian Knowledge, and is now reprinted by the Youngs for the American public. It is not a highly technical work from the strictly engineering point of view, nor is it designed as a treatise on hygiene for the use of medical officers of health and sanitary experts, though even experts will find much of interest in it; but it is planned for the use of the general householder no less than for those more closely interested in the sanitation of buildings. The author will be remembered as an expert having wide experience in examining and dealing with insanitary buildings.

THE ENCYCLOPEDIA OF FOUNDING AND DICTIONARY OF Foundry Terms Used in the Practice of Moulding. By Simpson Bolland, Practical Moulder and Manager of Foundries; Author of "The Iron Founder." New York: John Wiley & Sons.

THE character of this book, so far as its purpose is concerned, is sufficiently indicated by its title, which purpose seems to have been well achieved in the body of the work. The book contains 535 pages, and is a valuable edition to the technological literature of foundry work. The author is a well known and accomplished writer upon the art of founding and subjects connected therewith and to those acquainted with his previous works no other recommendation of his present treatise will be needed.

HENDRICKS' ARCHITECTS AND BUILDERS' GUIDE AND Contractors Directory of America, for 1894-95. New York: Samuel E. Hendricks Co., No. 61 Beekman street. [Cloth. 8vo. XXX-709 p. $5.]

THIS annual publication, embracing this year over 170,000 names allied with the construction industries of the country, merits commendation for its completeness, accuracy, and good arrangement. It is a book of great value to the classes named in its title as printed above, and also for manufacturers or dealers in material of every kind required in building. The names and addresses given are classified both as to States and as to the occupations and materials referred to.

BOOKS RECEIVED.

Halliday, George.=Belt Driving. Illustrated. New York: Spon & Chamberlain. [Cloth. 8vo. 100 p. $1.50.]

Jackson, Frank G.=Theory and Practice of Design: an advanced text-book on decorative art. Illustrated. Philadelphia. [imported by] J. B. Lippincott Co. [Cloth. 8vo. $2.50.]

Johnson, Emory R.=Relation of Taxation to Monopolies. Philadelphia: American Academy of Political and Social Science. [Paper. 8vo. 67-93 p. 25 cents.]

Johnson, F. R.=Stresses in Girder and Roof Trusses for Both Dead and Live Roads. Illustrated. New York: Spon & Chamberlain. [Cloth. 12mo. 215 p. $2.50.]

Kitchen-Boiler Connections; practical letters and articles relating to water-backs and range-boilers compiled from the *Metal Worker*. Illustrated. New York: David Williams. [Cloth. 8vo. 6-129 p. $1.]

MacFadden, Charles K., *and* Ray, William D.=The Practical Application of Dynamo-Electric Machinery. Illustrated. Chicago: Date & Ruggles. [Cloth. 16mo. 167 p. $1.]

Medicus, Ludwig.=Qualitative Analysis: for use in instruction in chemical laboratories. Translated by John Marshall. Philadelphia: [imported by] J. B. Lippincott Co. [Cloth. 8vo. $1.50.]

Poor, H. V.=Poor's Manual of the Railroads of the United States for 1894. (Twenty-seventh year.) New York: H. V. & H. W. Poor. [Cloth. 8vo. 1800 p., 70 maps. $7.50.]

Roberts, Charles W.=Practical Advice for Marine Engineers. Illustrated. New York: Spon & Chamberlain. [Cloth. 12mo. 150 p. $1.]

Smith, Edgar F.=Electro-chemical Analysis. Illustrated. (Second edition.) Philadelphia: P. Blakiston, Son & Co. [Cloth. 12mo. 143 p. $1.25.]

NEW TRADE CATALOGUES.

These catalogues may be had free of charge on application to the manufacturer.

The Hawley Down Draft Furnace Company, Chicago, Illinois, U. S. A.=Descriptive pamphlet of Hawley Down Draft Furnace System, pink and gold cover, 50 p. [The descriptive text is illustrated by colored lithographic plates, the whole being printed in the most elegant manner. There are eight of these colored plates and 129 engravings, illustrative of buildings in which this system has been installed, and also of the installments themselves, among which a conspicuous example is that of a 4000 horse-power plant in process of erection at the Harrison street station of the Chicago Edison Company. The completed boiler plant at this station will aggregate 20,000 horse-power. A full exposition of the system is given with a long list of tests for determination of economical results. These economical results are obtained by smoke prevention. The system demonstrates that smoke can be prevented and money saved. Many valuable tables are contained in the pamphlet. Among these are a number showing results of tests made with different types of boilers which have been fitted with the Hawley Down Draft Furnaces which cannot fail to be of great interest to steam engineers. A table of cost of evaporating 1000 pounds of water by the use of coal as fuel, also a table showing cost of evaporating 1000 pounds of water with different grades of fuel and varying evaporations, also another giving cost of evaporating 1000 pounds of water, per pound of oil, another giving approximate cost of the labor required in evaporating 1000 pounds of water with coal as fuel, another giving approximate cost of labor required in evaporating 1000 pounds of water when oil is used as fuel, a code of rules for boiler tests recommended by the American Society of Mechanical Engineers, a table of data to be obtained in testing steam boilers and reporting the trial with a form for reducing these data, and making a record of the tests, a table of sizes of chimneys with appropriate horse-power of boilers, three pages of practical and useful information for steam users, two of editorial comment, testimonials, and a long list of steam plants equipped with Hawley furnaces, are comprised within the limits of this very complete and well prepared pamphlet.]

Neptune Meter Company, New York, U. S. A.=(1) Descriptive Pamphlet of the Trident water meter, 31 p. Cover buff, green and gold. [A beautifully printed trade publication. Topics noted in the margin of pages. Is a full exposition of the construction and operation of this water meter. (2) A Communication of General Interest in Regard to Disk Actions, 5 p. (3) Having Reference to Oscillating Disk Actions, 22 p. (4) A Mascot, 4 p. (5) On Ice, and the Dynamics of Frost as Affecting Water Meter Practice, 13 p. (6) Compound Action, 14 p. Describes and illustrates a new system of spur gearing used in the Trident Water Meter compound gear train. Each of these belong to the Trident Water Meter Series. Copyright, 1894.]

The Lunkenheimer Co., Cincinnati, New York, U. S. A., London.=Illustrated Catalogue and Price List, 1895. Brass and Iron Valves, Lubricators and Steam Specialalties. 107 p. [Contains descriptions and prices of an extensive line of goods.]

New Jersey Car Spring and Rubber Co., Jersey City and New York, U. S. A.=84 p. [Gives descriptions and illustrations of nine regular styles of hose aside from fire hose, to wit, "Staple," "Hudson," "Reliable," "Red Jacket," "Pearl," "Emerald," "Extra Pará," "Special," and XX Special," and also of an extensive line of other rubber goods, with price lists. Contains also blank memorandum pages.]

Consolidated Car-Heating Co., Albany, N. Y., U. S. A.=Advance Sheets, Part XII, 1895 edition. Electric Heaters. 31 p. [Other parts sent on application.]

Smith and Winchester Co., Boston, Mass., U. S. A.=21 p. [Describes the Winchester Steam and Hot Water Heating Boilers. Beautifully printed in tints, and contains sizes, capacities and prices.]

Carson Trench Machine Co., Charlestown, Boston, U. S. A.=Catalogue C. 37 p. [Concerning the Carson-Lidgerwood Cableway, introduced as "Trainor's Cable System" for excavating and refilling all kinds of trenches. Beautifully printed with elegant illustrations of numerous instances of work in progress wherein the system and its operation are exemplified.]

U. S. Heater Co., Detroit, Mich., U. S. A.= Warmth for Winter Homes. 75 p. [An essay on Domestic Heating, heating of greenhouses, schools, hospitals, baths, etc. Also containing descriptions of the Capitol Heater for hot water and steam, with sizes, capacities and prices, and report of an expert on the same. Also containing descriptions of the "Hecla" and "Mascot" Heaters, with sizes and prices. 79 p. Beautifully illustrated with engravings of residences and other buildings in which the heaters manufactured by this company have been placed.]

The Electric Boiler Co., Rochester, N. Y., U. S. A.=38 p. [Describes and illustrates the construction and use of the "Electric Boiler," with table of sizes, capacities, etc., and price list.]

G. A. Crosby & Co., Chicago, Ill., U. S. A. =4th edition Catalogue of Prices, Dies and Special Machinery for Sheet Metal Workers. 188 p. [Illustrations of Machines and Tools, with descriptive text, sizes, capacities, weights, etc.]

Westinghouse Electric and Manufacturing Co., New York, Boston, Chicago, Charlotte, Philadelphia, St. Louis, San Francisco, Portland and Syracuse, U. S. A.=1. "Stopper Incandescent Lamp." 27 p. [Statement of the use and economy of this lamp at the World's Fair. Illustrations of the lamp and of processes used in its manufacture and the adapters best suited for use with different sockets.]

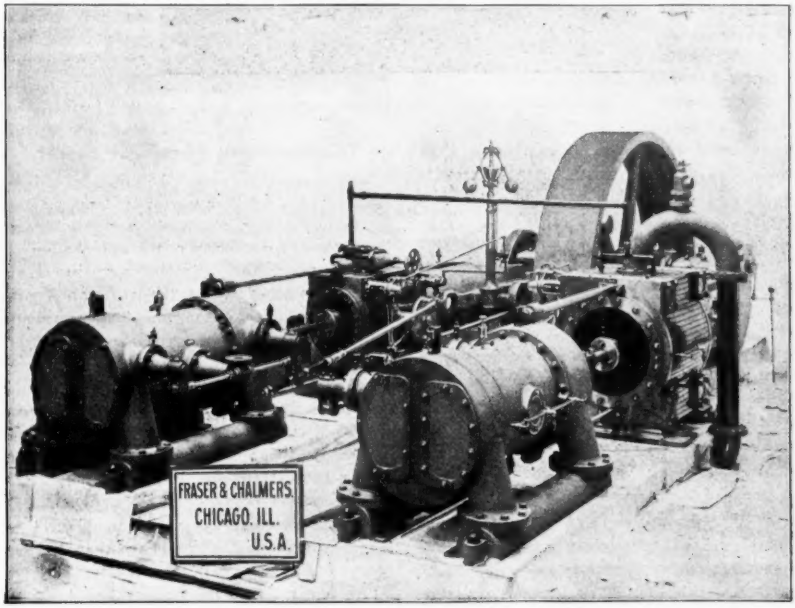
For additional Catalogues see "Improved Machinery," page 32.

IMPROVED MACHINERY

The matter published in this department is not paid for, nor can it be classed as advertising But as the information is necessarily obtained from those who offer the appliances for sale, it is proper to say that the manufacturers, rather than ourselves, are responsible for the statements made.

The Riedler Air Compressors.

THESE compressors like the Riedler pumps embody the principle of positive mechanical closure of the valves, which are at the same time allowed to open freely under suitable difference of pressures. The difference of pressures necessary to open the valves is reduced to a minimum by constructing them in two parts, a light loose ring which lifts readily, and a valve body or catcher which limits the movement of the ring, and is itself closed by the mechanical movement, carrying the ring with it. The mechanical closure being a rocking movement derived from the wrist plate of the Corliss driving engine favorable to smooth and quiet seating, and closure can be adjusted nicely to the piston velocity, while the shocks incident to tappet movements are avoided. The adaptation of these machines (whether pumps or compressors) to the actual conditions of fluid flow and pressure is the outcome of the scientific researches of Professor Riedler, whose "Indicator-Versuche an Pumpen" records a great number of tests of pumps, and reaches new conclusions of the highest practical value. These ideas so abundantly demonstrated in European practice require only finely-executed mechanism for the realization of exceedingly good results, permitting higher speed and better service.



THE RIEDLER AIR COMPRESSOR.

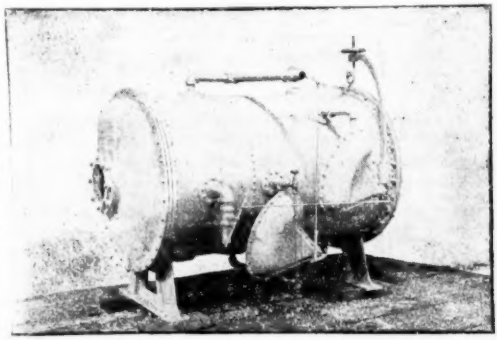
It has devolved upon Fraser & Chalmers

Chicago, U. S. A., controlling the Riedler system, to furnish proof of its working merits in this country. Of air and gas compressors alone, a number have already been built and installed in the United States. Of these we illustrate an 18" × 30" duplex Riedler compressor driven by an 18" and 28" × 30" Corliss compound engine for the Milwaukee Mining Co., Idaho. This takes the place of a smaller compressor of another make, and it is claimed does twice the work on one-fourth less fuel, so that the cost of fuel for similar work is as 1 to 2¾ between new and old plants. In this case, wood being $3.50 a cord the reduction of fuel bill on the power now used amounts to $9000 a year. This result is due in large measure to the better adjustment of engines to their load, and to good steam engineering, but it is also an illustration of the success of the Riedler system.

A 14" × 24" Riedler duplex air compressor driven by a 16" × 24" duplex Corliss engine installed for the Horn Silver Mining Co., Utah, is also stated to give complete satisfaction to the purchasers; and an 18" × 30" Riedler single air compressor driven by a 16" × 30" Corliss engine installed for the Alaska Mexican Mining Co., Alaska, is pronounced by their superintendent, Robert Duncan, Jr., after an experience with many other makes, to be the best and most economical compressor that he has handled.

Stillwell's Patent Improved Heater.

THIS apparatus is designed expressly to meet the requirements of architects and engineers in connection with the steam heating of large buildings. Exhaust steam is utilized for heating the feed-water. The cylinder oil is removed from the exhaust steam before it enters the heater, which contains a large area of removable shelves that serve the double purpose of heating the feed-water and depositing the scale producing salts. It also contains a very large space for holding heated feed-water and returns. It effects absolute and automatic control of feed-water and returns. The manufacturers, Messrs. Stillwell and Bierce, Dayton, Ohio, guarantee its reliability and effiency, and will supply further information on application.



STILLWELL'S IMPROVED HEATER.

Foreign Trade.

IT is learned that the Buffalo Forge Co., Buffalo, N. Y., recently received an order for a large outfit to be shipped to Revel, Russia, for drying veneers. The parties buying the outfit having tried various plans of seasoning this material with very unsatisfactory results, after investigating a plant previously installed by the Buffalo Forge Co., were so well pleased with that outfit that they found it unnecessary to look further.

The Modemann Street Car Fender.

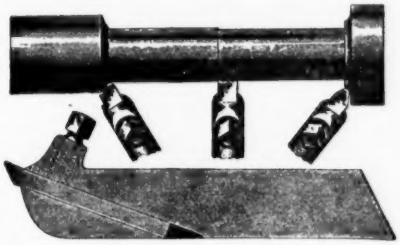
THE most urgently needed of all street railway improvements has been a good car fender. The Modemann fender has passed severe tests and is stated to have received the approbation of railway authorities. This fender consists of an appliance attached partly to the platform and partly to the dashboard of the car. The framework of the fender consists of vertical iron rods fixed to the dashboard and having at the lower ends toggle joints removably mounted and sliding on the frame. Supporting bars extend forward from these toggle joints which collapse beneath the weight of a body which falls upon a wire netting attached. Extensible wings are provided at either side, which when the fender is collapsed, rise and extend horizontally. The fender is oscillating, so that when the car rises or tilts forward it cannot be lifted too high for utility, nor can it strike the ground forcibly. The fender is light, strong and durable, and being collapsible and offering little resistance, it breaks the fall of the person in collision, and also sustains no injury in slight contacts with trucks or other obstacles. It is also removable, and can be shifted from one end of the car to the other in a moment by one man. It also folds up readily, taking no additional room in the car sheds. It is simple in construction and all parts

are inexpensive and supplied by the manufacturers on short notice. It is claimed that this device will absolutely prevent loss of life and serious injury, and has none of the serious defects which have characterized other previous inventions.

The United States Street Car Fender Co., whose offices are in the Bennett Building, Nassau street, New York, is placing these fenders on the market, and will supply full information regarding them.

The Armstrong Tool Holder.

THE cuts illustrate this excellent device, and are sufficiently explanatory in themselves to obviate the need of special description. These holders are equally adapted for use in lathe and planer work, and are designed both to supply a good and practical substitute for forged tools, and to facilitate the use of self-hardening steel,



ARMSTRONG TOOL HOLDER.

for which they are especially adapted. It is stated with reference to this tool-holder, that it has been used by many prominent concerns, and is, by those who have used it, unanimously con-

ARMSTRONG TOOL HOLDER.

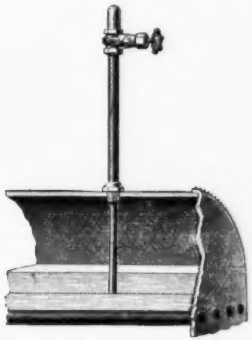
ceded to be the best tool-holder yet produced. It is manufactured only by Armstrong Bros. Tool Co,, 76-78 Edgewood Ave., Chicago, Ill., U. S. A.

Western Twist Drills.

IT is with pleasure announced that at the Antwerp Exposition the Cleveland Twist Drill Company were awarded a gold medal for the excellent quality of their exhibits of twist drills. For many years it was believed by mechanics that first class tools could only be obtained from eastern manufacturers, but the success of the exhibits of the enterprising company named will go far toward exterminating the last remains of this false notion.

Lunkenheimer's Low Water Alarm.

THIS alarm is of the kind known as "fusible alarms," that is to say its action depends upon the melting of a fusible plug when the latter is exposed to a temperature due to the access of steam to it. A low water alarm is an absolute requisite in modern steam boiler practice; and as this appears unusually simple and reliable in its indications, it would seem to meet all possible requirements. It has no floats or complicated whistle-blowing arrangements, but is simply a tube with one end reaching down to the low water



LUNKENHEIMER'S LOW WATER ALARM.

line while the other has a valve and fusible plug attached. The operation is described as follows:

When the water in the boiler drops below the end of the tube it drains the water out of the tube and permits steam to enter, which melts the fusible metal and with a loud report the steam hisses through the pipe, and thus gives notice of the approaching danger. The valve is then shut off; a new fusible disk attached; the valve opened, and the alarm is again ready. Each alarm is supplied with several fusible disks, and extra ones can be supplied at a small cost.

The Lunkenheimer Company, Cincinnati, O., U. S. A., are the sole manufacturers of this neat, simple and effective device.

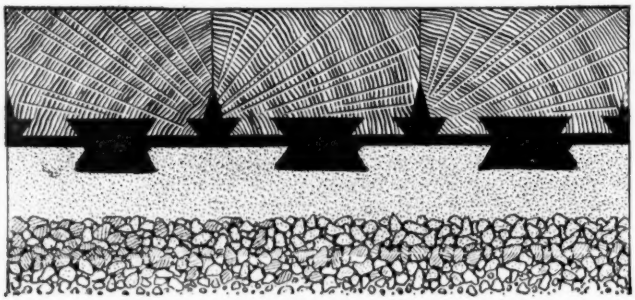
Machine Made Block Flooring.

THE problem of compound floor construction has always rested mainly on the points—how to

obtain a perfect bond or connection between the blocks themselves, and how to obtain a perfect and enduring cohesion between the concrete and cement substratum and the superimposed wooden blocks. Interposition of a layer of asphalt cement only partly meets the difficulty, for asphalt has not sufficient adhesion to concrete.

It is claimed that by the use of wood blocks prepared by machines devised for the purpose, in such manner that each block may be securely anchored to the concrete, the solution of the problem of compound flooring is now reached. The wood blocks having been machined to form dovetails on the lower side as shown in the engraving, every block is firmly anchored to the concrete foundation by a bituminous compound which not only serves as a damp and vermin-proof course but forms also a double dovetail key binding the wood floor and the concrete foundation into one solid immovable and unshrinkable structure.

The wood blocks used for this kind of flooring are about 18 inches long and from 2⅛ to 3 inches wide, varying in thickness from 1 inch to 1⅜ inches. They are made from carefully selected, well seasoned, and thoroughly kiln-dried lumber, and are molded and cut up by machinery designed and built especially for the purpose, insuring such an absolutely mathematical exactness that when laid they fit together with an accuracy that makes the joints almost imperceptible. They may be so laid as to form beautiful, straight, herring-bone, basket, or interlacing patterns.



MACHINE MADE BLOCK FLOORING, WILSON SYSTEM.

This flooring is known as the "Jas. G. Wilson's System," after the patentee and manufacturer, Mr. James G. Wilson, 74 West 23d street, New York.

NEW TRADE CATALOGUES.

These catalogues may be had free of charge on application to the manufacturer.

2—Protection from Lightning. 32 p. [Describes and illustrates the Wurts Non-Arcing Metal Lightning Arrester, for alternating current circuits. Gives testimonials.]

3—Discriminating Lightning Arresters, and Recent Progress in Means for Protection Against Lightning, by Alexander J. Wurts. 67 p. [A paper presented at the Eleventh General Meeting of the American Institute of Electrical Engineers, Philadelphia, May 16, 1894, and at a meeting of Western members, Chicago, May 23, 1894.]

4—Catalogue No. 65. 55 p. [Instructions for Operation of Nos. 10 and 12 Single Reduction Equipments. Treats of car apparatus, gives instruction for handling it, also instructions to inspectors, and directions for shipping and mounting.]

5—Multipolar Generators and Motors. 16 p. [Treats of Generators and Motors from ¾ horse power up. With illustrations and tables, including a Wire Table for 100 and 500 Volt Circuits.]

The Johnson Railroad Signal Co., Rahway, N. J., Boston, Mass., and Chicago, Ill, U. S. A.=[Reference Book of Parts in connection with Interlocking and Block Signaling. 1894. Special Awards at World's Fair, Chicago, 1893. 241 p. Flexible covers; rounded corners; pocket book size. 1507 illustrations.]

United States Heater Co., Detroit, Mich., U. S. A.=Capitol, Hecla and Mascot Hot Water and Steam Heaters, Radiators, Valves and Pipe Fittings, with Price Lists and Directions for Setting the Capitol and Hecla Heaters. 440 p.]

The Norwich Insulated Wire Co., New York, Chicago, Boston, San Francisco, New Orleans, U. S. A.=46 p. [Describes and illustrates with beautiful lithographs a great variety of light and power cables.]

For additional Catalogues see "New Books of the Month," page 579.